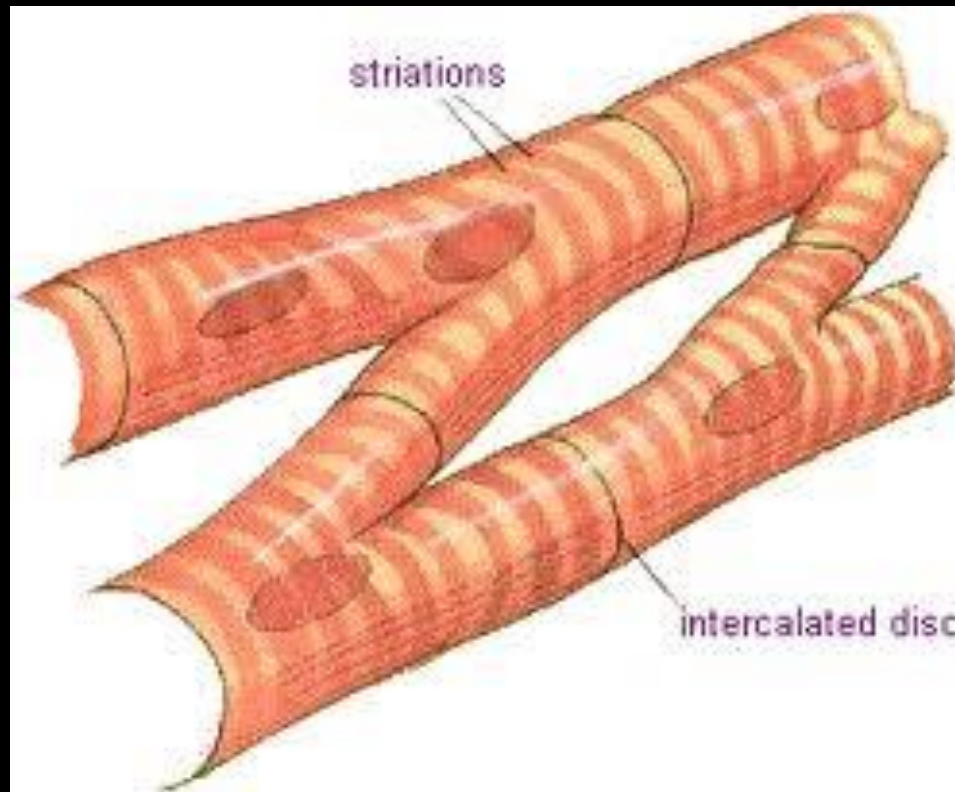


Musclular Tissue



Objectives

- Describe the general features of muscle tissue
- State the arrangement of connective tissue around muscular tissue
- Describe the terms muscle fibre, myofibrils and myofilaments
- Describe the histological features of different types of muscular tissue
- State the ultra-structural features of the contractile unit of the skeletal muscle
- Relate functional adaptations of different types of muscle tissues

Tissue

- Collections of specialized cells and cell products that perform a specific function.

Four Primary Tissue

Epithelial tissue

Connective tissue

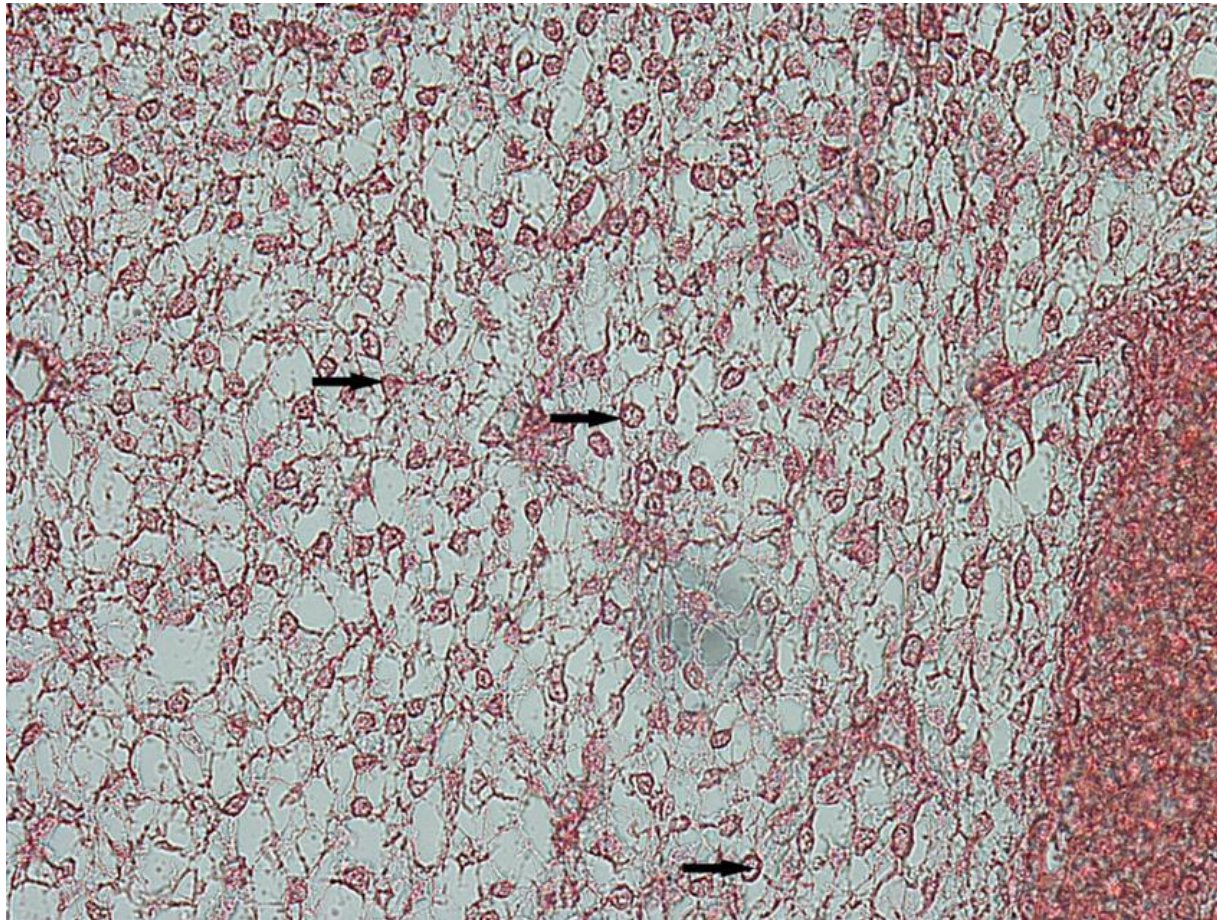
Nervous tissue

Muscular tissue

Four Primary Tissue

- **Epithelial**
covers exposed surfaces, lines passageways, forms glands.
- **Connective**
fills internal space, structural support, storage of energy.
- **Muscle**
contracts for specific movements.
- **Neural**
carries information from one part of the body to another.

Muscular tissue – embryological origin



Primitive mesenchyme

irregular cells + slender processes

Terminology

- muscle fiber = muscle cell (elongated and thread like)
- sarcoplasm = cytoplasm of the muscle fiber
- sarcolemma = muscle fiber plasma membrane
- sarcoplasmic reticulum = smooth endoplasmic reticulum of the muscle fiber

General features of muscle tissue

- Derived from the primitive mesenchyme
- Consists of highly differentiated cells; muscle fibers
- Organized as muscle fiber bundles, sheaths
- Arrangement of connective tissue is important
- Characteristic ultra-structural arrangement helping the contraction
- Chief structural proteins are actin and myosin

General features of muscular tissue

- Chief action is contraction – active process
- Able to contract because of the presence of fibrillar proteins arranged in an organized manner linked by inter-molecular bonds
- Contraction is due to rearrangement of bonds
- Contractile force, power and range differ
- Muscle fibers able to change shape during contraction
- Convert chemical energy to mechanical energy

Muscular Tissue Types

Skeletal muscle

Smooth muscle

Cardiac muscle

Classification of muscular tissue

Base on
structure

- Striated
- non –striated

functional
&
structural

Base on
function

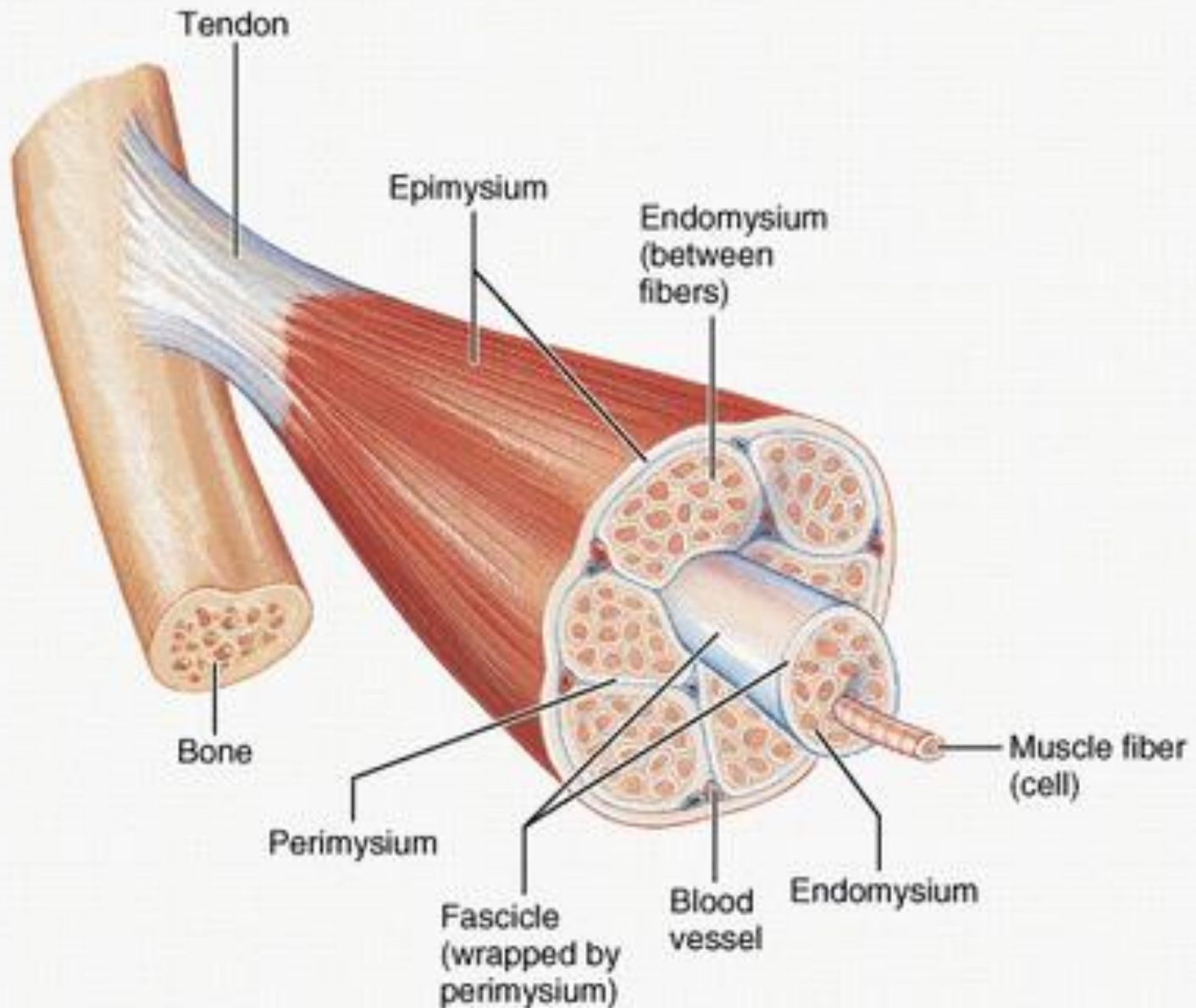
- voluntary
- involuntary

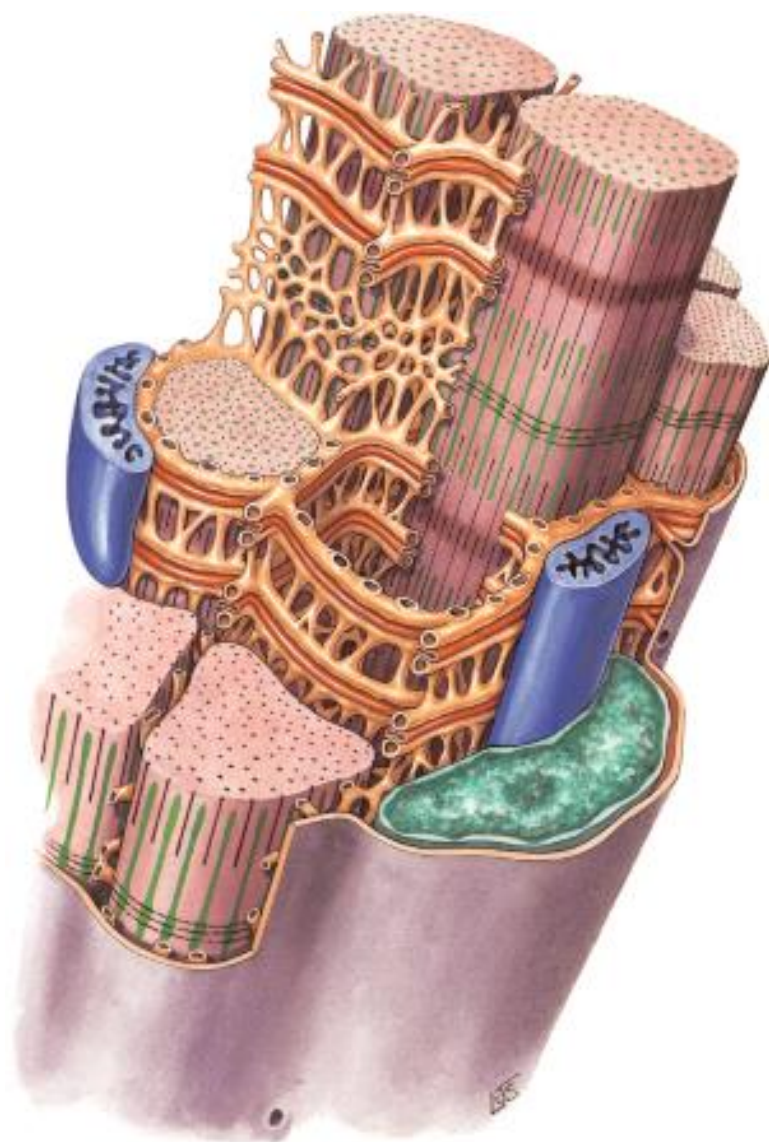
- striated & voluntary = skeletal muscle
- striated & involuntary = cardiac muscle
- smooth & involuntary = smooth/visceral muscle

Skeletal muscle

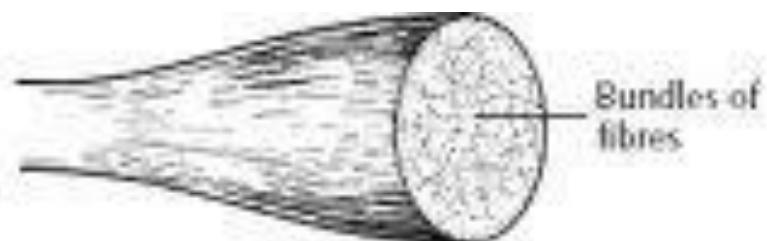
- Single cell– muscle fibre
- Bundle of fibres– single muscle fascicle
- Many fascicles– single muscle
eg: Biceps, triceps

Skeletal muscle

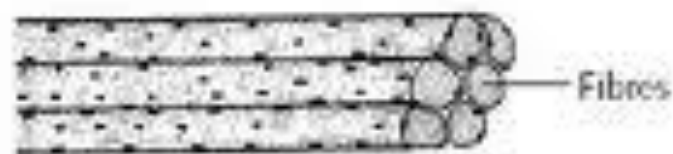




(a)
Muscle



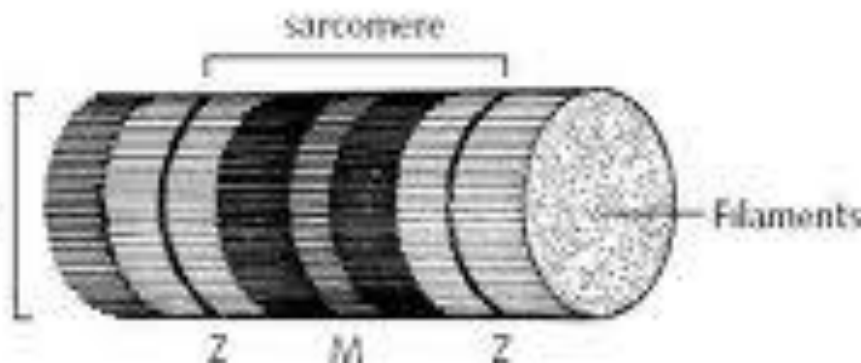
(b)
Bundle of fibres



(c)
Fibre
50 μm



(d)
Myofibril
1 μm



Muscle fibre

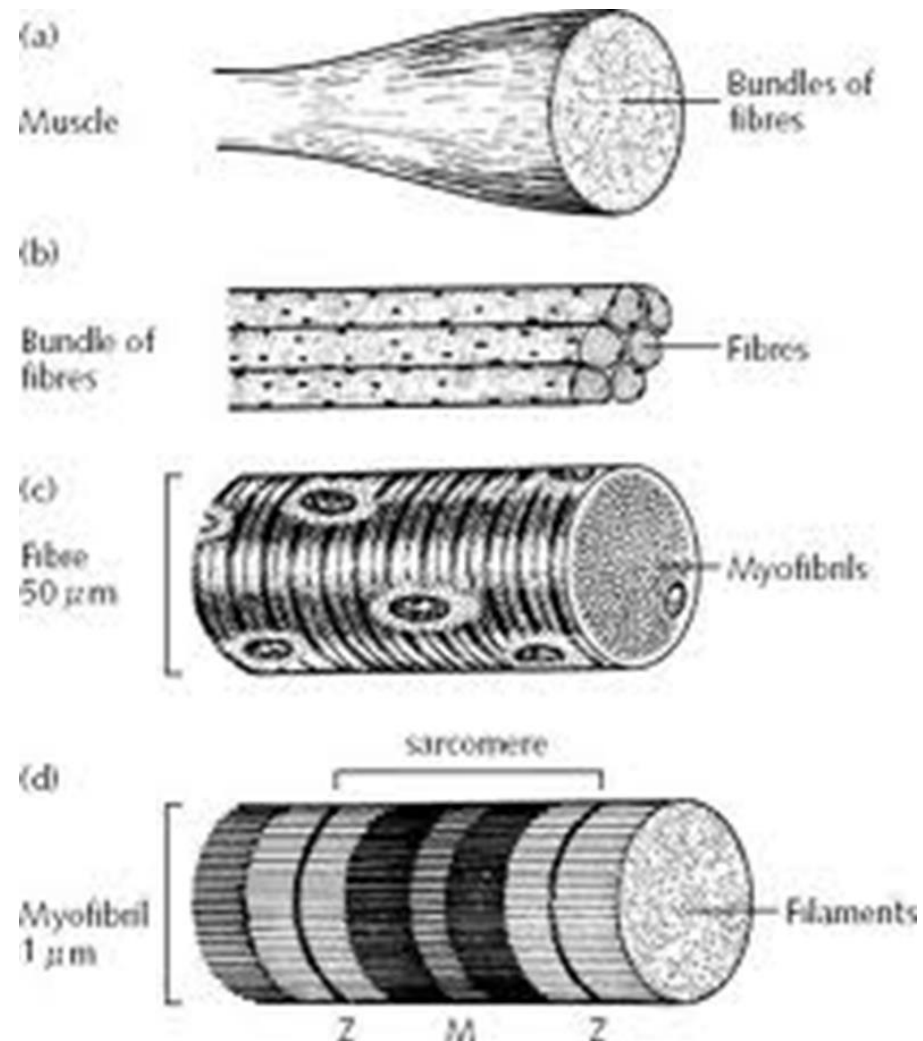
- Long and cylindrical shape
 - Cross section – polygonal
- Length : 10–100 μ m
- Unbranched fibre
- Multinucleated
- Peripherally located oval euchromatic nuclei
- Nuclei located under sarcolemma
- Each fiber surrounded by external basal lamina
- Fibers can increase in size but not in number

Muscle fibre

- Contractile proteins arrange in cylindrical **myofibrils**
- each fiber contains dozens of myofibrils
- each myofibril is about 1–2 μm in diameter
contains myofilament bundles

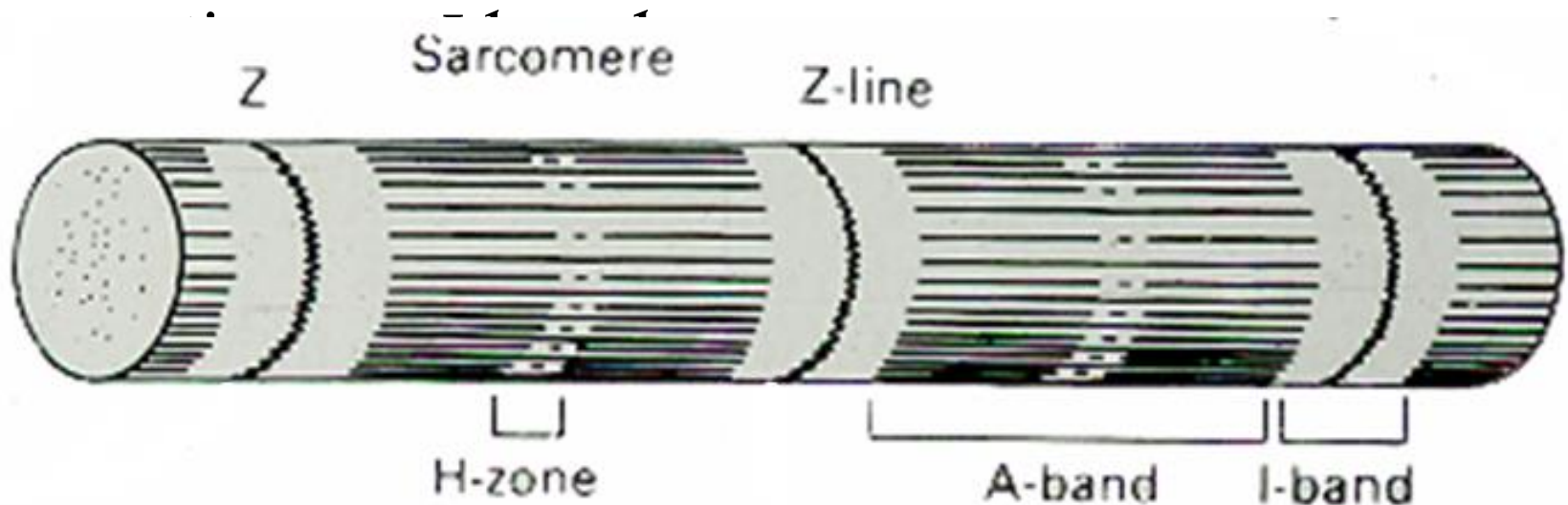
Myofibril structure

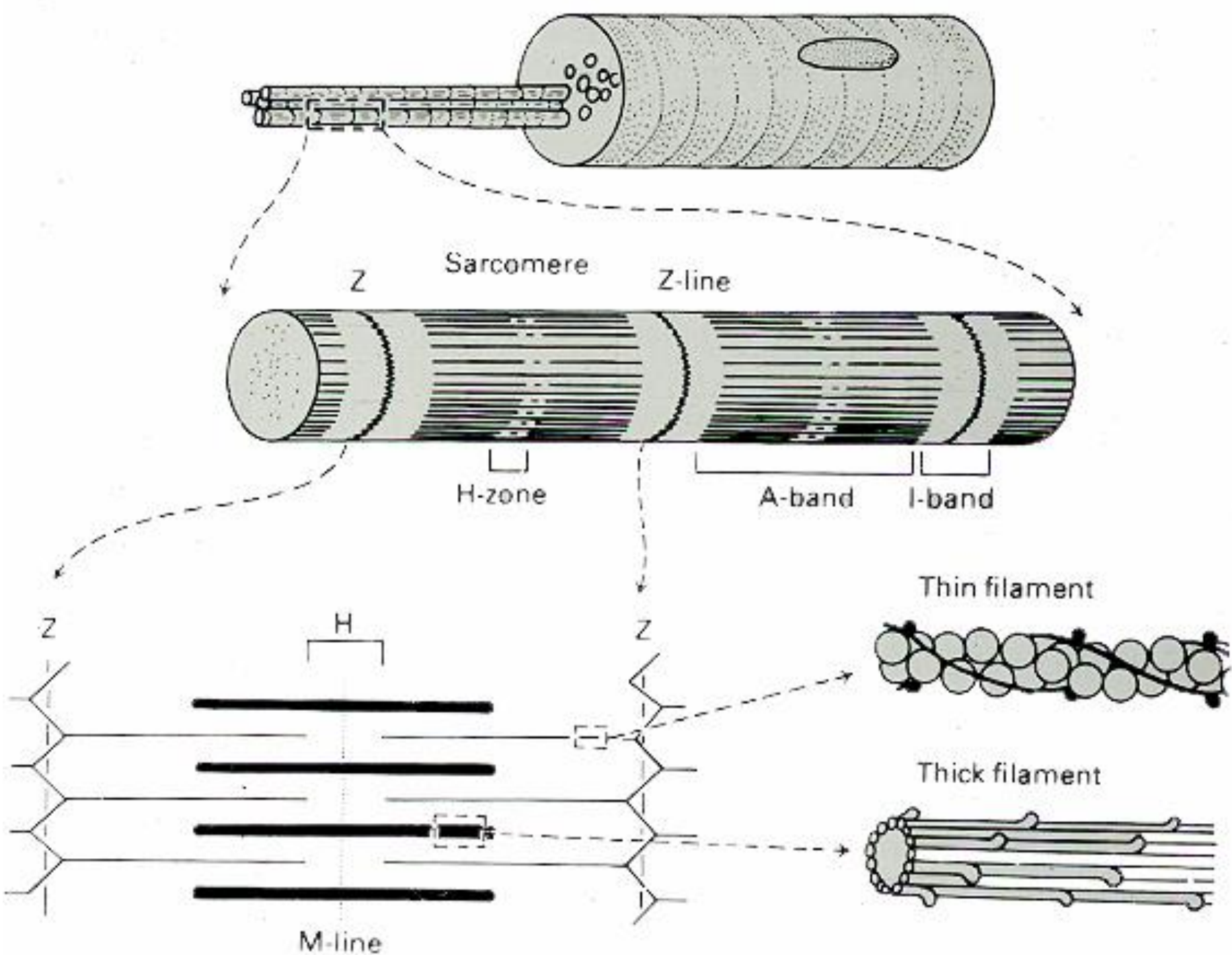
- Cylindrical
- Diameter $1\text{ }\mu\text{m}$
- Densely stained transverse lines– Z lines
- Area between two consecutive Z lines– Sarcomere (Contractile unit)



Sarcomere

- **Functional unit** of a muscle fibre
- The segment between two successive densely stained Z lines
- Includes one A band and half of two





Sarcomere



Z disk

M line

Z disk

Thin filaments

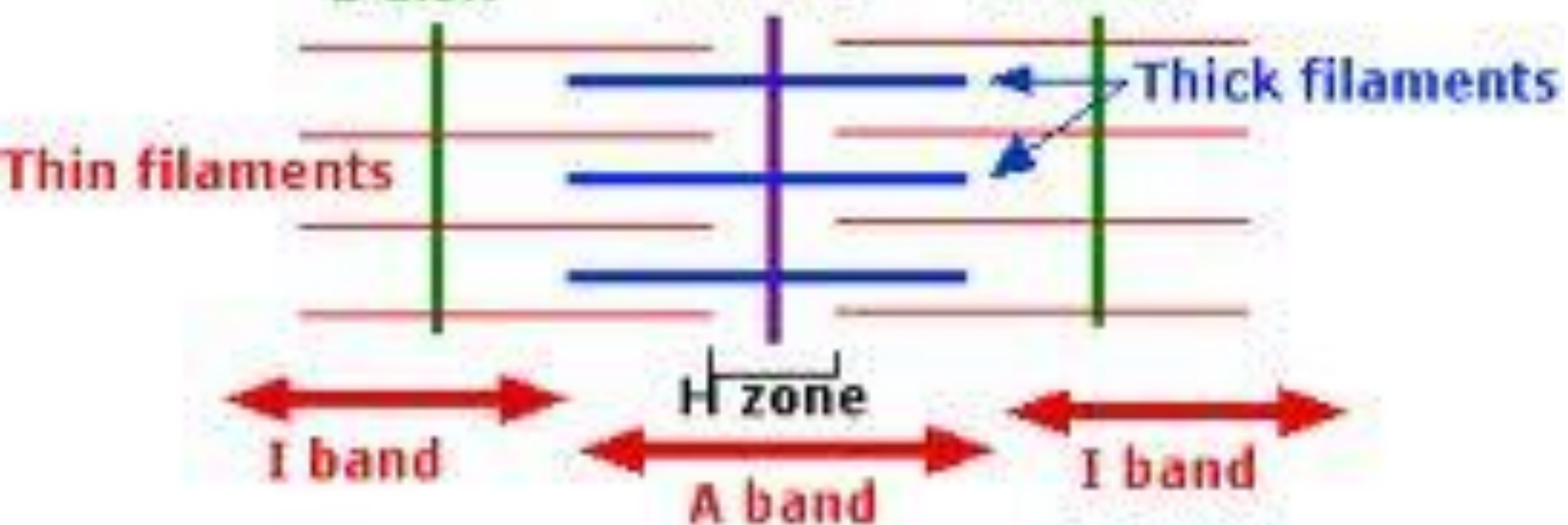
Thick filaments

I band

H zone

A band

I band



Important muscle proteins

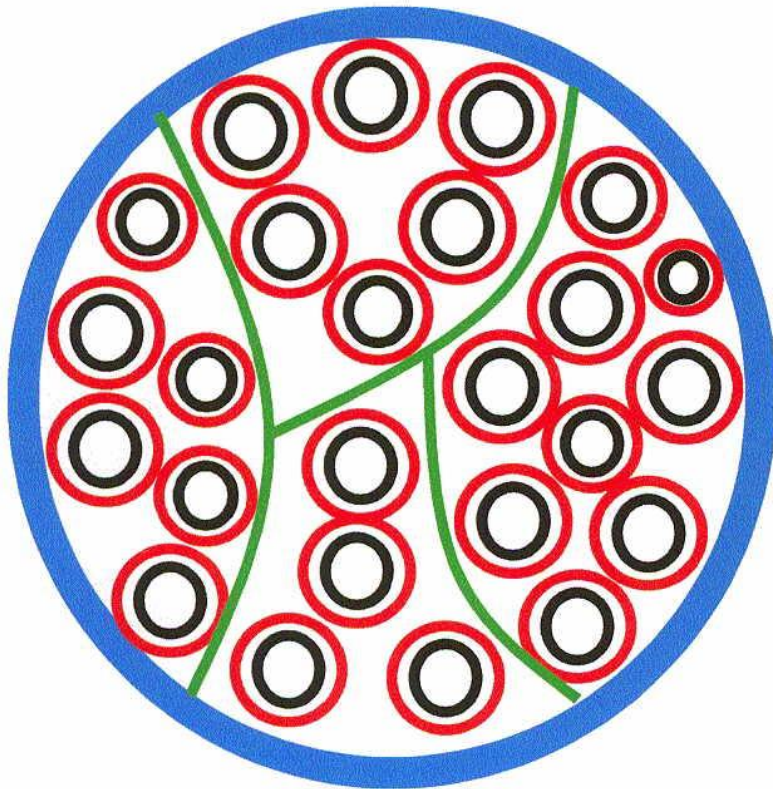
- Myosin–most abundant, forms the *thick filaments*
- Actin – forms *thin filament*
- Tropomyosin & troponin
Contractility regulating proteins
- Dystropin– stabilizes muscle fiber and transmit force to the extracellular matrix
 - *Defective synthesis result in Duchenne muscular dystrophy*

Connective tissues of muscle

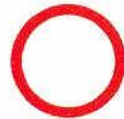
- Provides structural covering and support
- Maintains the shape of the muscle
- Act as attachments with the bone
- Transmit contractile force to the action site (eg joint movement)

-mysiums

(connective tissue coats of a skeletal muscle)



skeletal muscle fiber



endo - mysium



peri - mysium



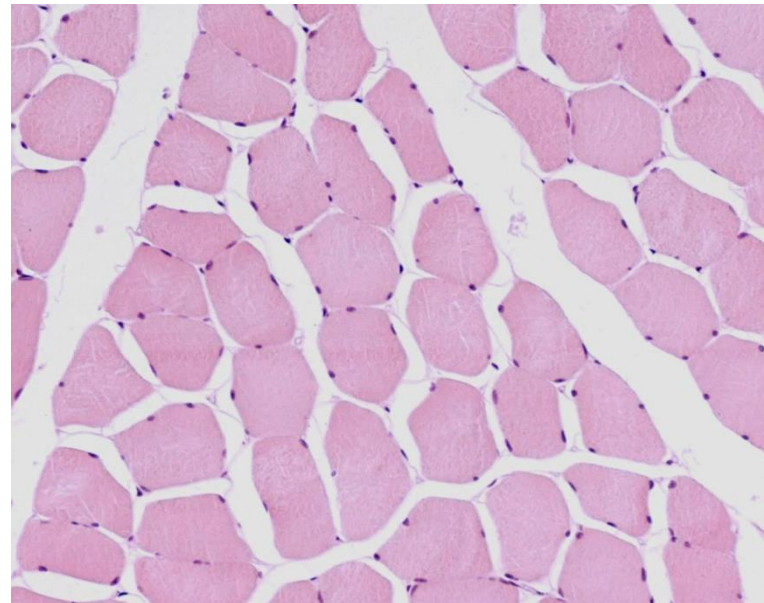
epi - mysium

Endomysium

- Thin , delicate reticular fiber network
- Surrounds each fiber & external lamina
- Forms immediate external environment of the muscle fiber
- Site of metabolic exchange between muscle and blood
- Continuous with the perimysium

Perimysium

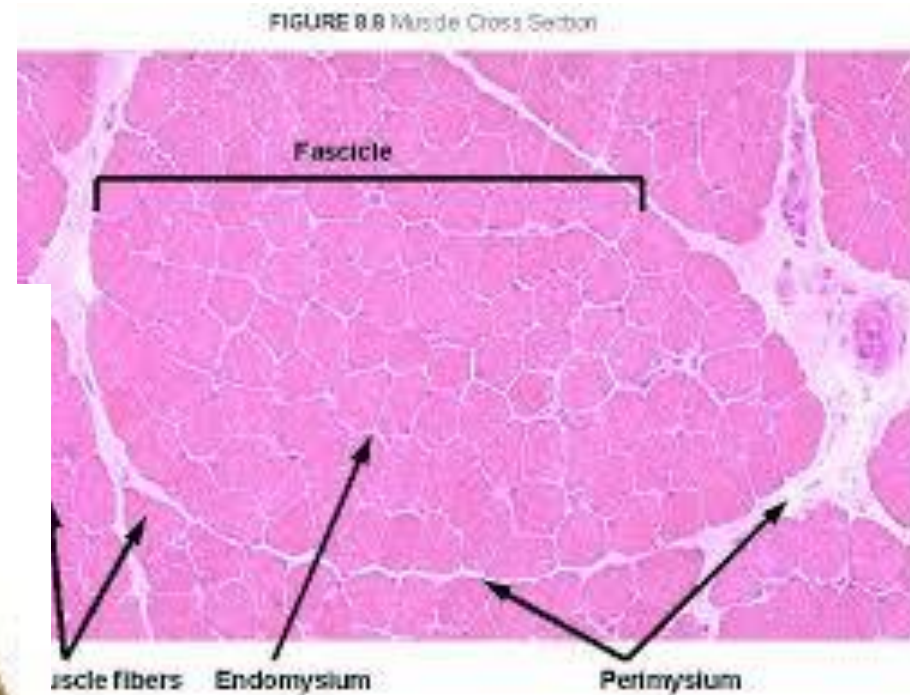
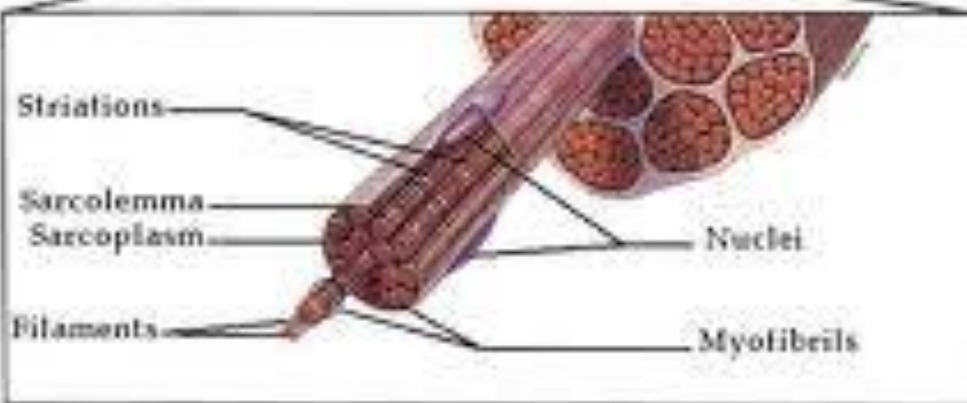
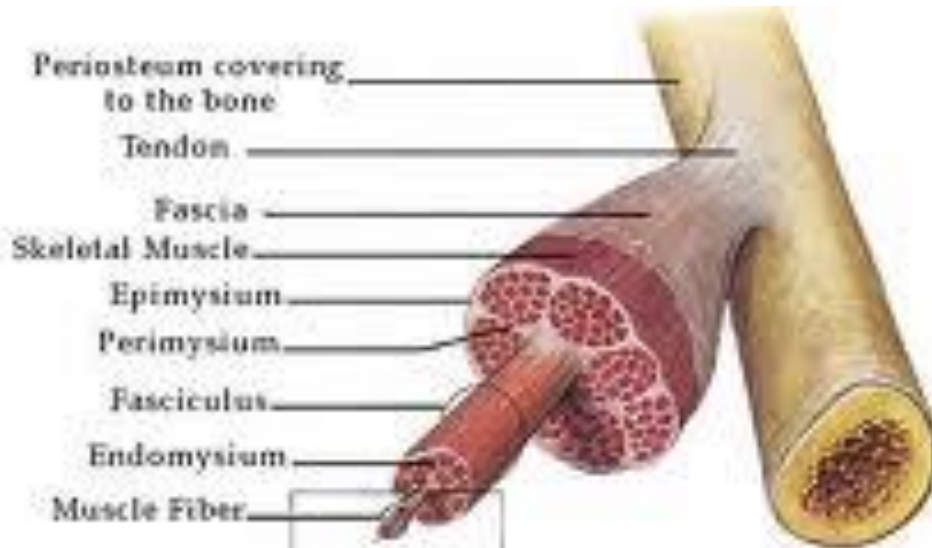
- Ensheaths groups of muscle fibers
- Inward extensions of the epimysium
- Therefore forms a muscle fasciculi
- Carries larger blood vessels and neuromuscular spindles



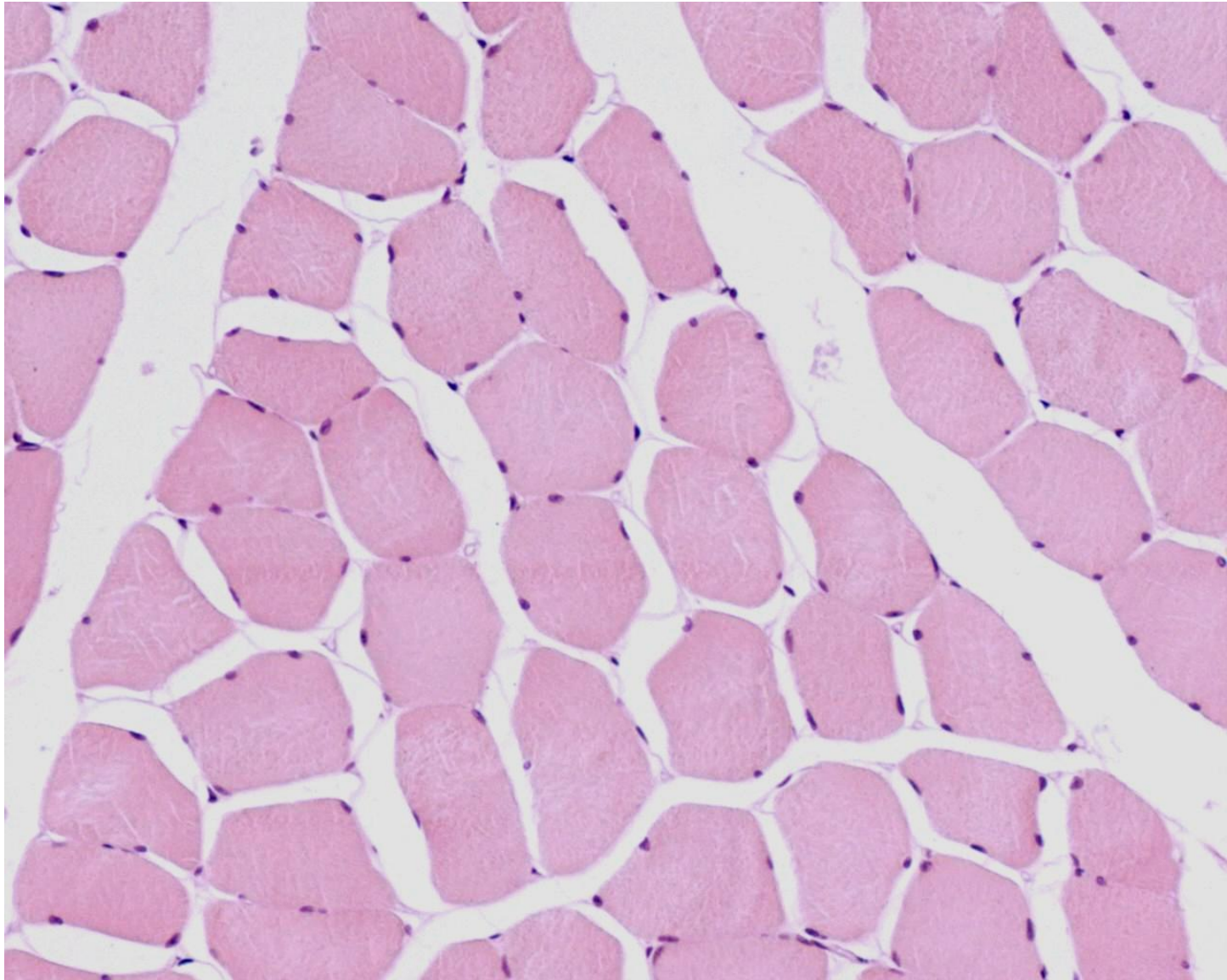
Epimysium

- Forms the entire outer covering of the muscle bulk
- Numerous collagen fibers arranged regularly

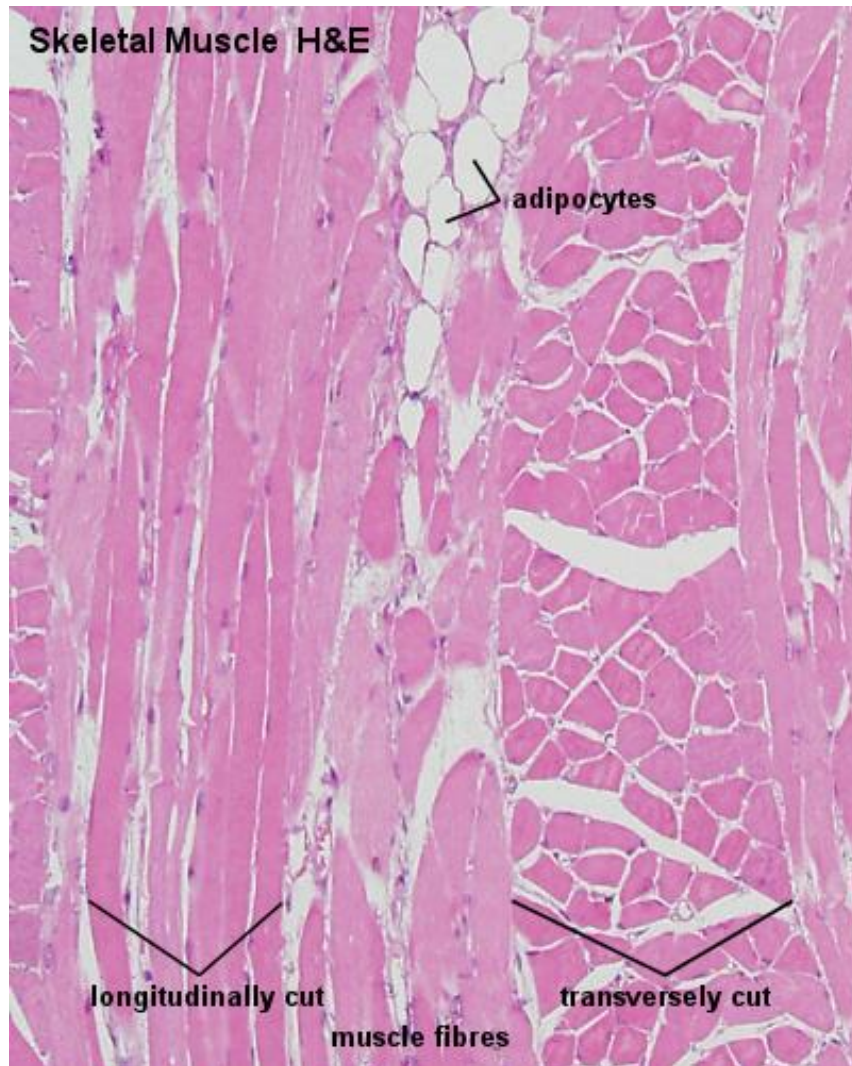
Skeletal muscle



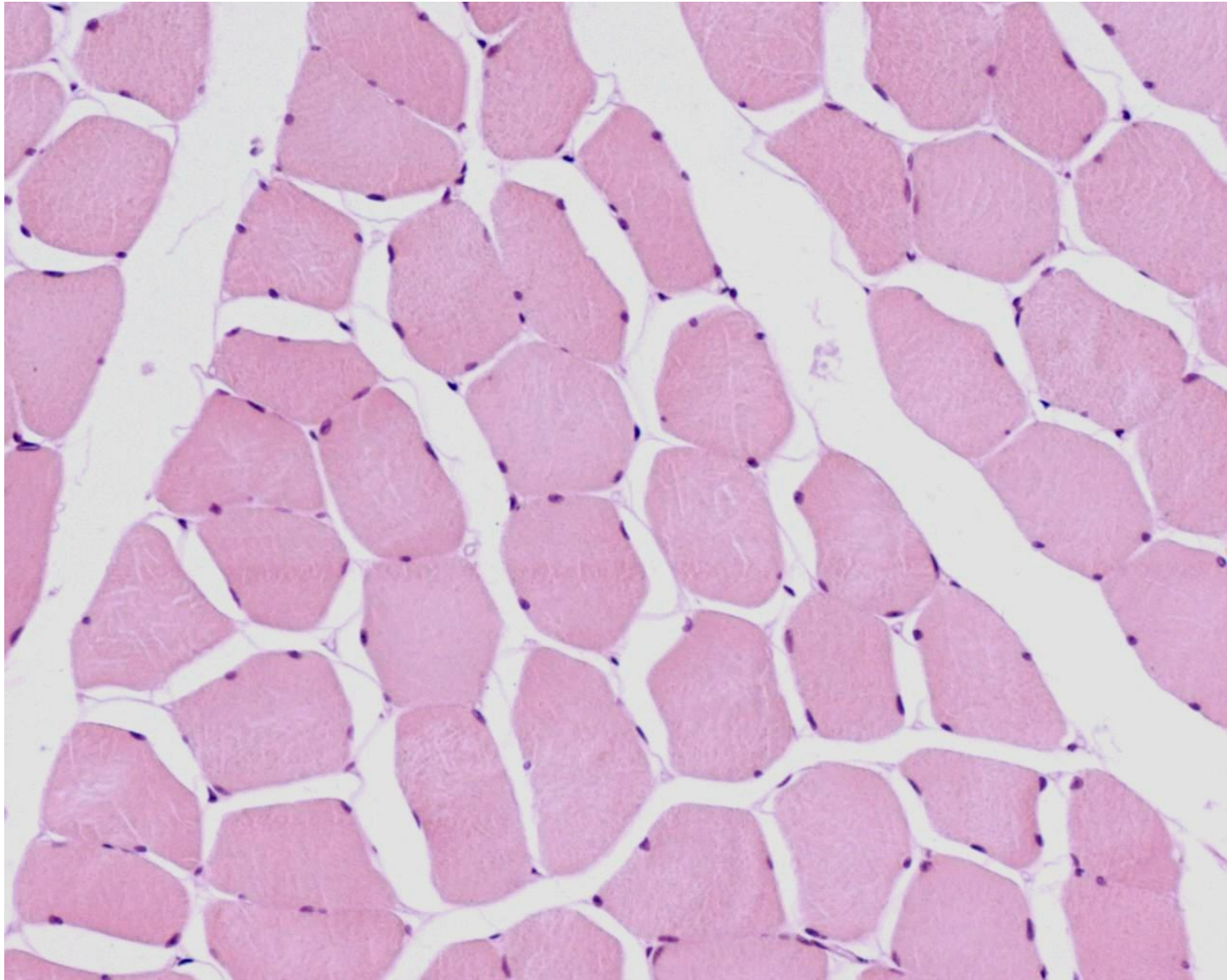
Skeletal muscle - H&E stain



Skeletal muscle - H&E stain



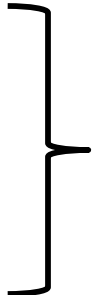
Skeletal muscle - H&E stain



Muscle Triad

- **Uniform contraction is maintained by system of T tubules**
- T tubules are deep invaginations of the sarcolemma encircle every myofibril at A-I junction
- On either side of T tubule are expanded terminal cisternae of smooth endoplasmic reticulum

SER
T tubule
SER



Muscle Triad

Muscular Tissue Types

Skeletal muscle

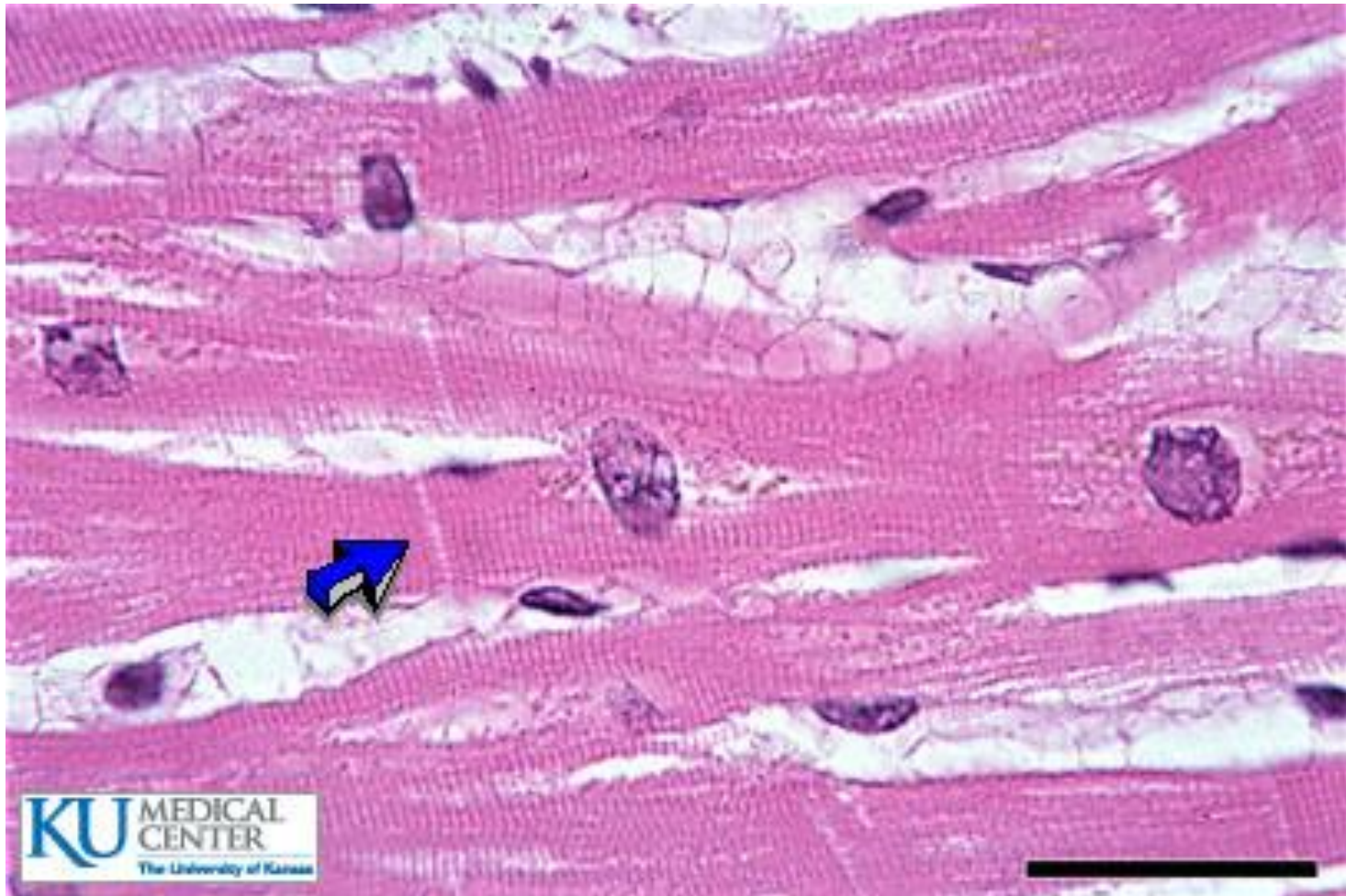
Smooth muscle

Cardiac muscle

Cardiac Muscle

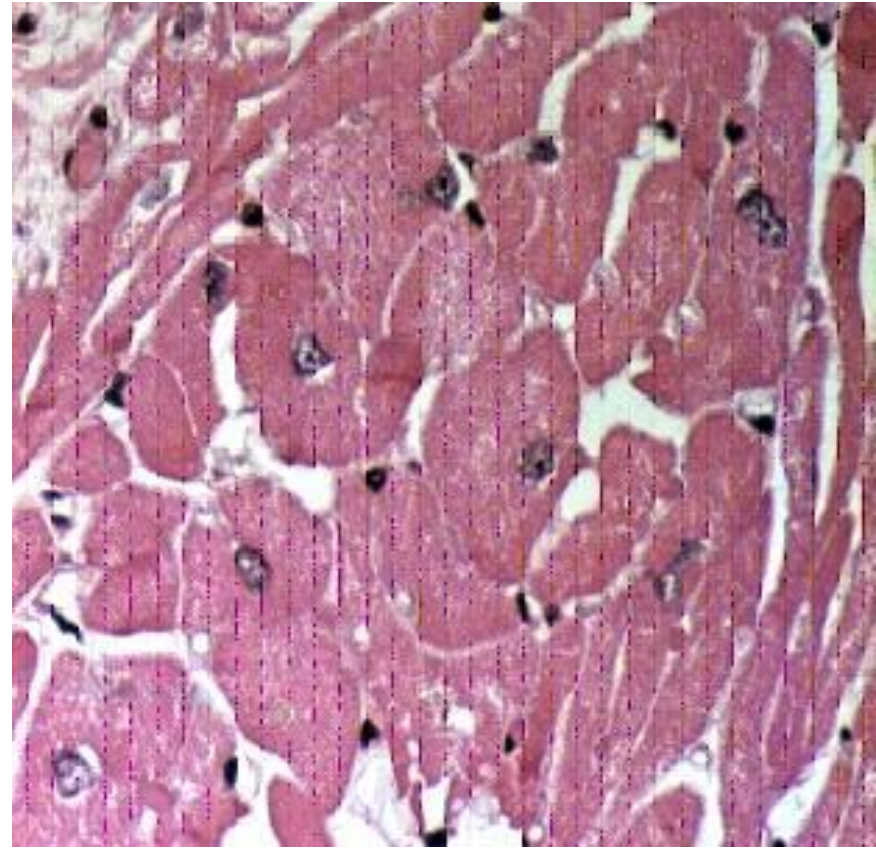
- Found only in the myocardium of heart & roots of large vessels
- Consists of **branching** network of individual cells
- **Cylindrical fibers** – intermediate size
- Anastomoses with adjacent fibers
- Therefore functions as a unit
- usually **one nucleus**
- Nucleus **located centrally**

- myofilaments organized into myofibrils
- Similar to skeletal muscle
- **Cross striations** present but faint



Cardiac Muscle - cell structure

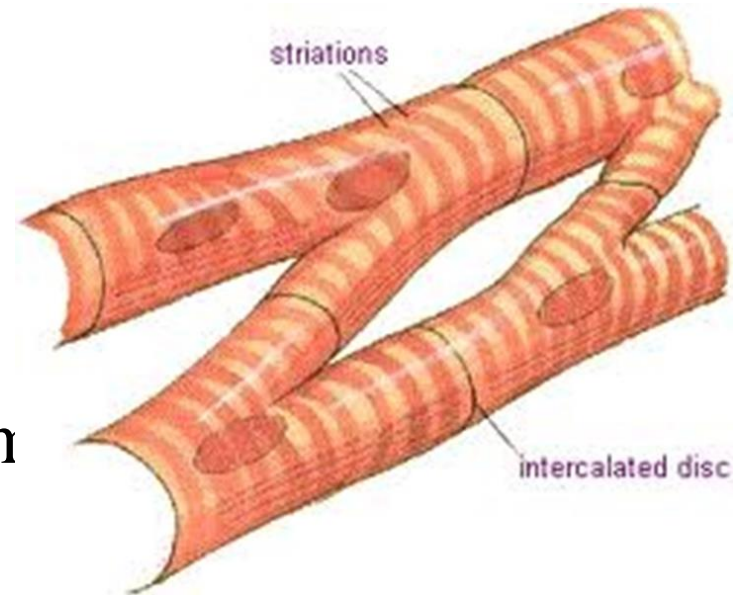
- fibers are arranged as interwoven bundles
- contractions in all dimensions
- highly vascular
- many mitochondria
- fibers capable of hypertrophy
- but not hyperplasia



Cardiac Muscle - cell structure

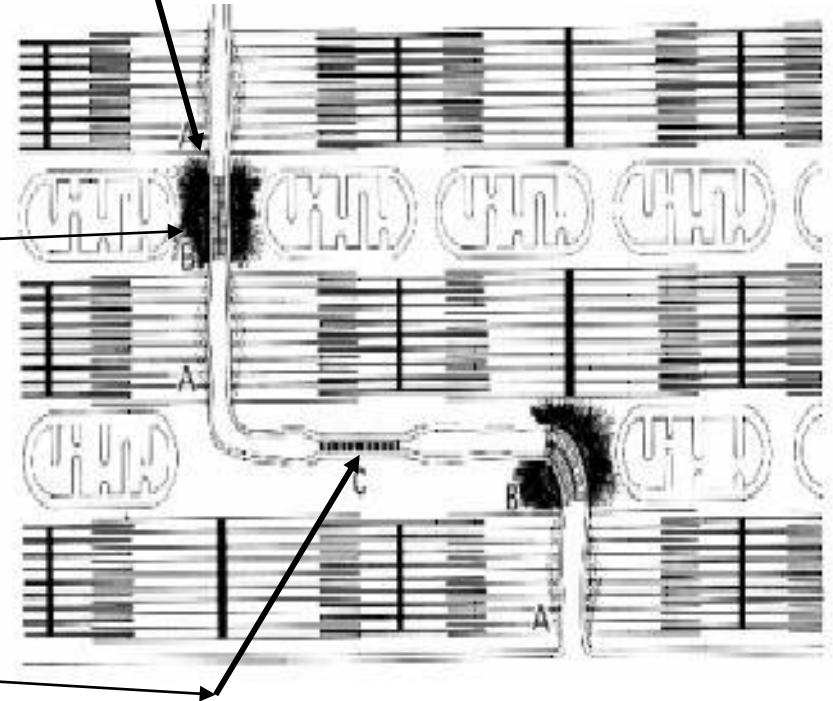
■ Intercalated discs

- unique to cardiac muscle fibers
- interdigitating fold of sarcolemma adjacent fibers
- linking them structurally and functionally by gap junctions and desmosomes unique to cardiac
- **functional syncytium**



Cardiac Muscle – cell structure

- **Intercalated discs**
- **A: fascia adherens**
terminal actin filaments
anchored → sarcolemma
- **B: macula adherens**
desmosomes
binds cells
- **C: gap junctions**
ionically couple cells



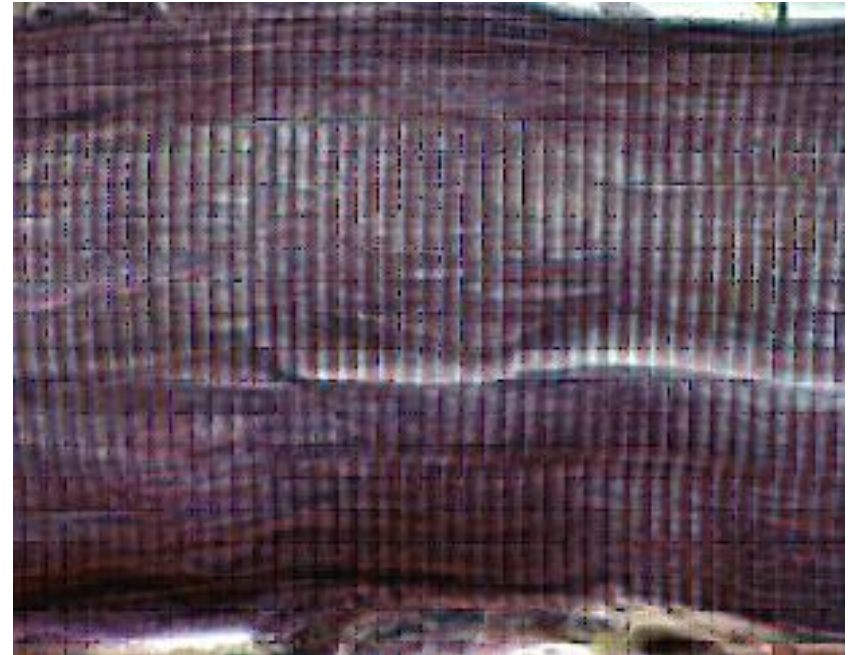
Contractile apparatus is as same as skeletal muscle fibers

- **T-tubule system similar:**

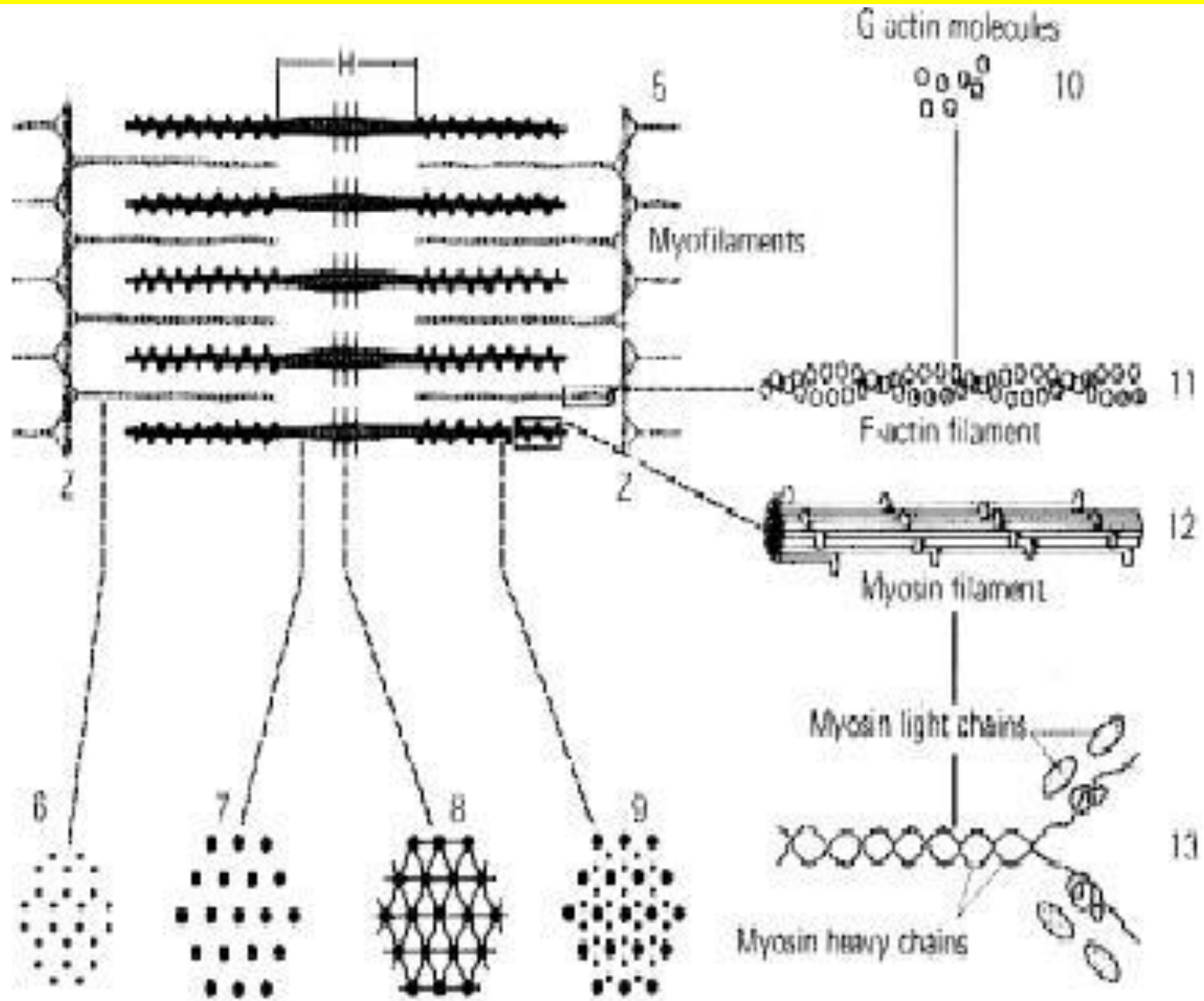
- T-tubules at the level of the Z-line
- no triads ← sarcoplasmic reticulum not well developed
- ionic coupling → regulates contraction through gap junctions

Cardiac Muscle - cell structure

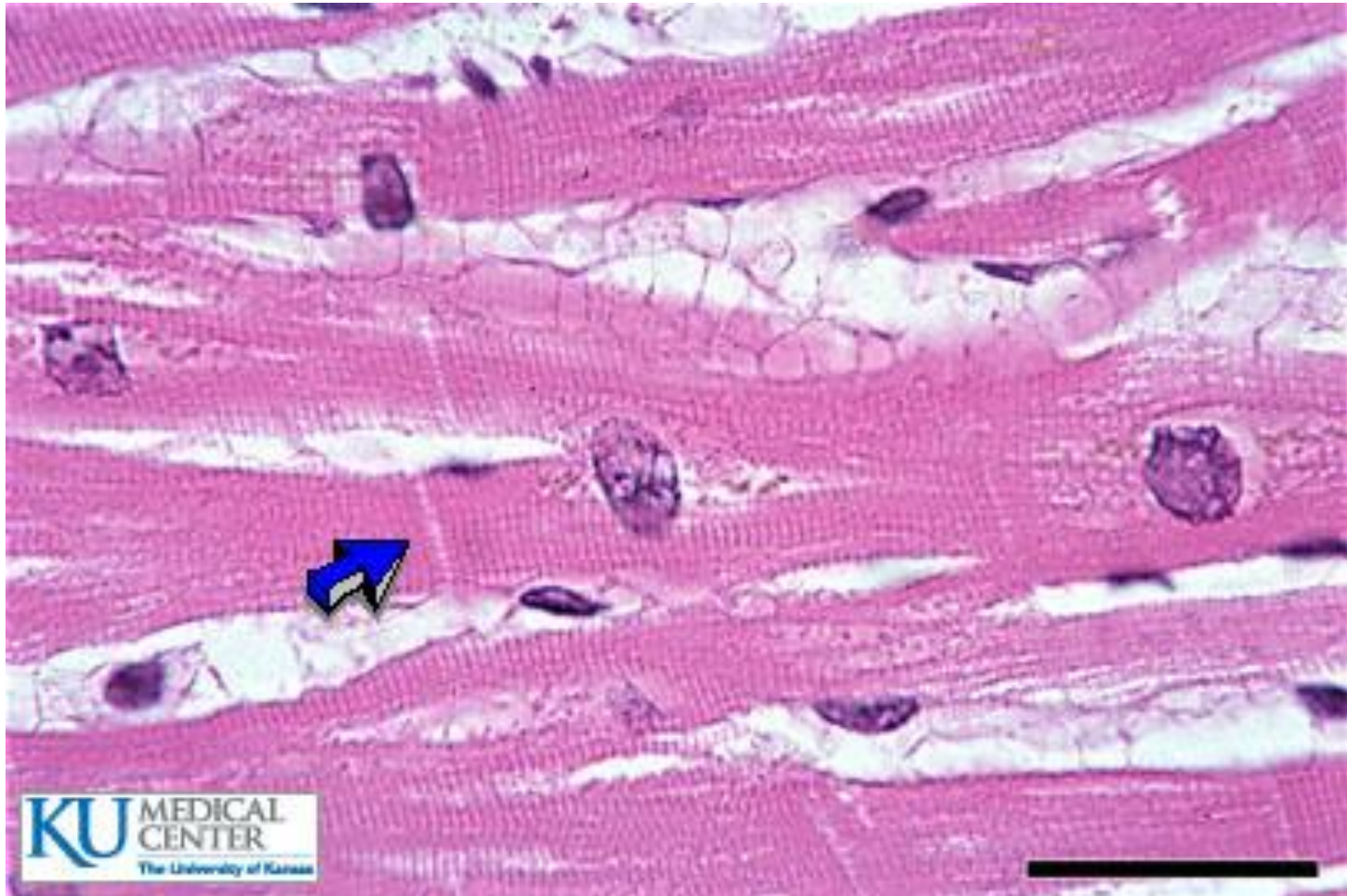
- **Banding pattern:**
 - myofilaments banding pattern
 - LM – light **I bands** and dark **A bands** easily visible



Cardiac Muscle - cell structure



Cardiac Muscle



Muscular Tissue Types

Skeletal muscle

Smooth muscle

Cardiac muscle

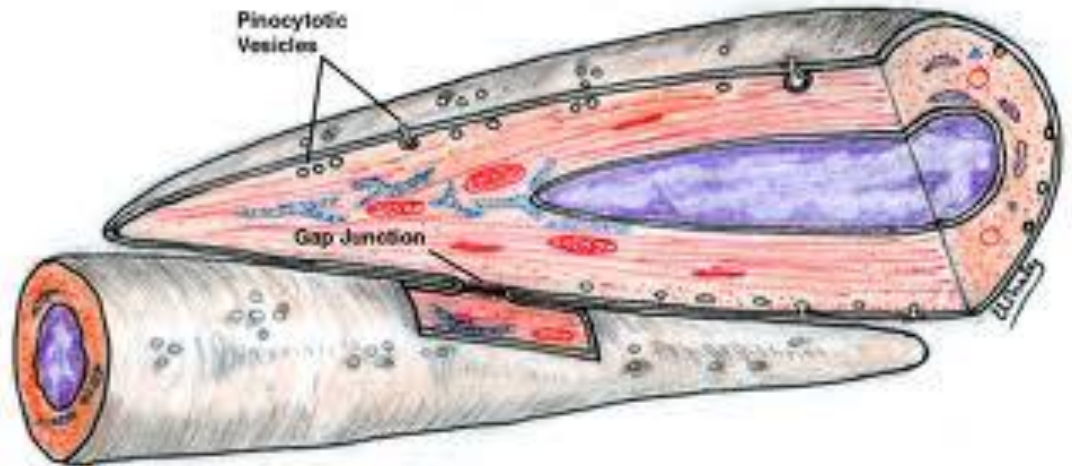
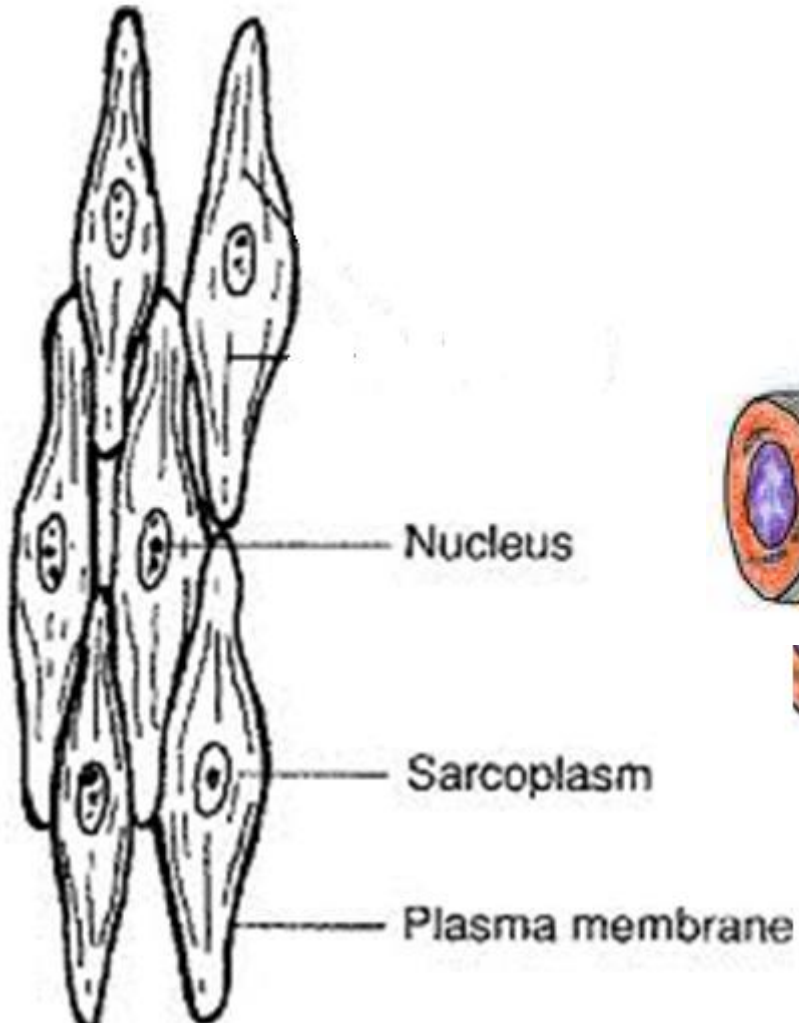
Smooth Muscle

- Involuntary action
 - Spindle shape cells
 - smallest fiber type
 - Tapering towards the end
 - non-branching
 - Single, centrally placed nucleus often twisted due to contraction
-
- Muscle cells arrange themselves longitudinally as sheaths
 - Gap junctions in adjacent myocytes

Smooth Muscle

- No sarcomeres
- Myofilaments : actin and myosin filaments
- No proper organization
- Myofilaments: criss-cross obliquely through the sarcoplasm
- Attached to dense bodies (actinin) dense bodies
- Myofilaments are inserted to dense bodies to transmit force of contraction

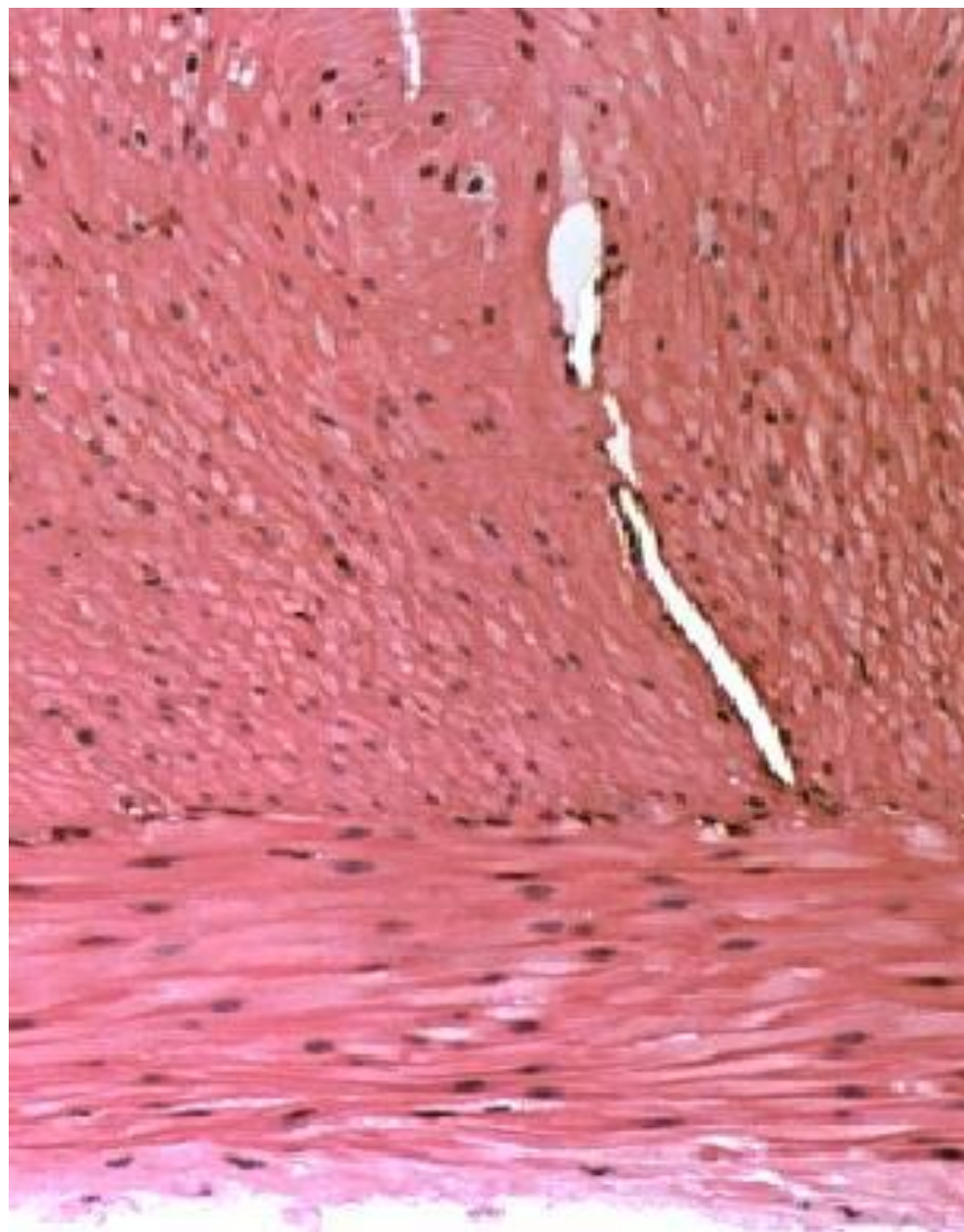
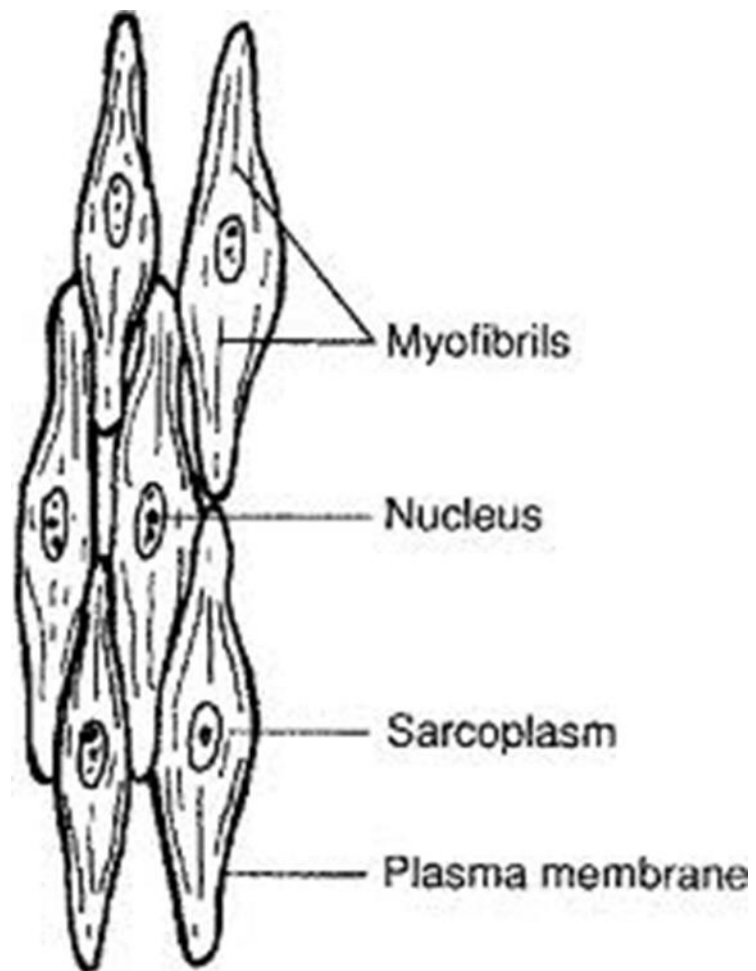
Smooth Muscle



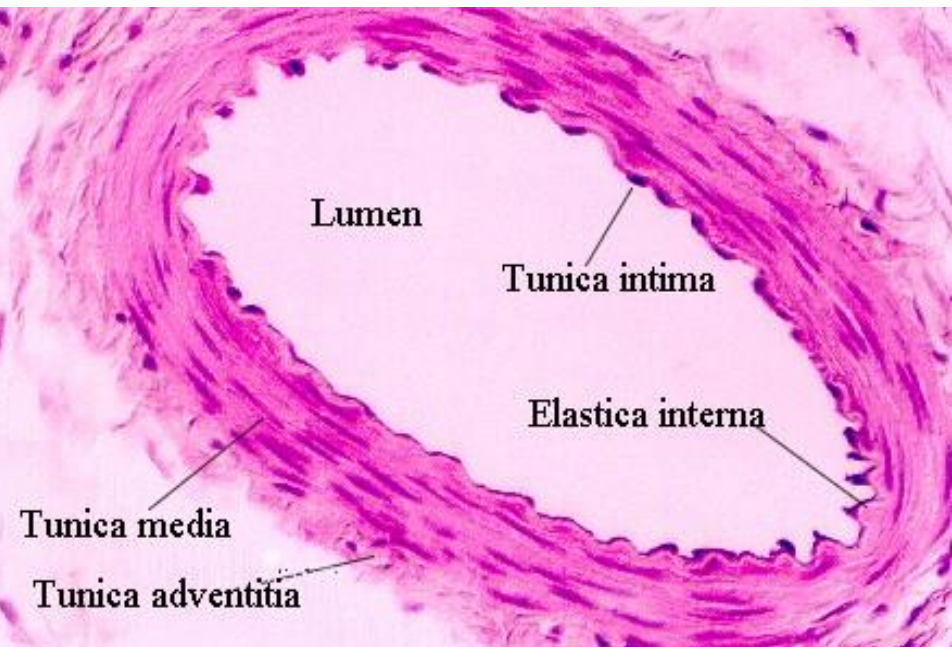
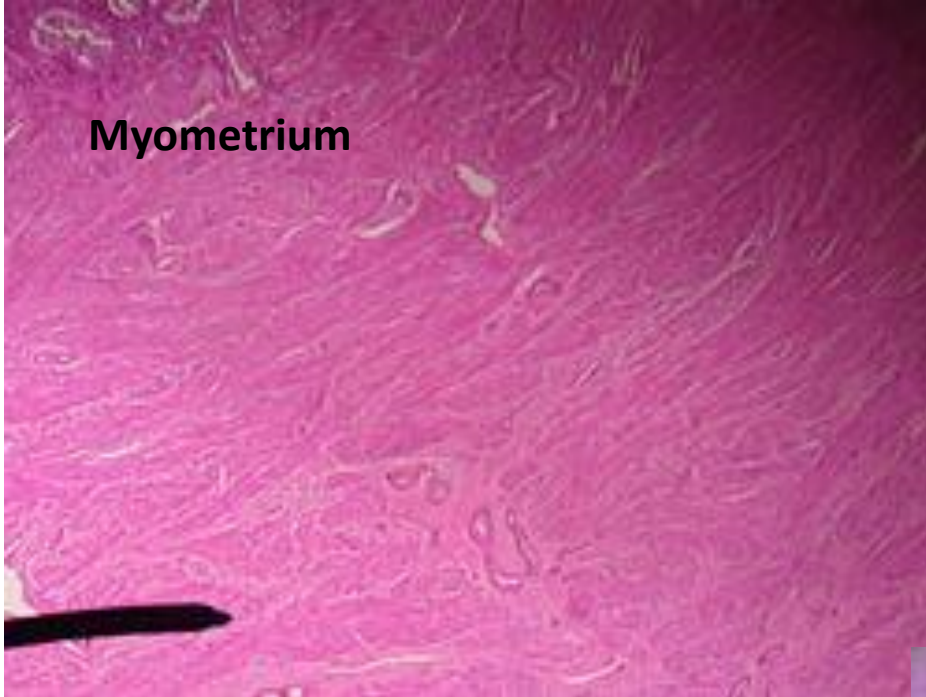
Smooth Muscle

- Typically found in walls of tubular structures
 - Blood vessels (20 μm), bronchial tree (regulating the flow of blood and air)
 - Ureteric wall (500 μm), hepatic duct, intestine muscularis propria (propels liquids and solids)
 - Urinary bladder, uterine myometrium (expels contents)
 - Secretory ducts

Arrangement of cells depends on the site and function of the organ



Myometrium



Muscularis propria



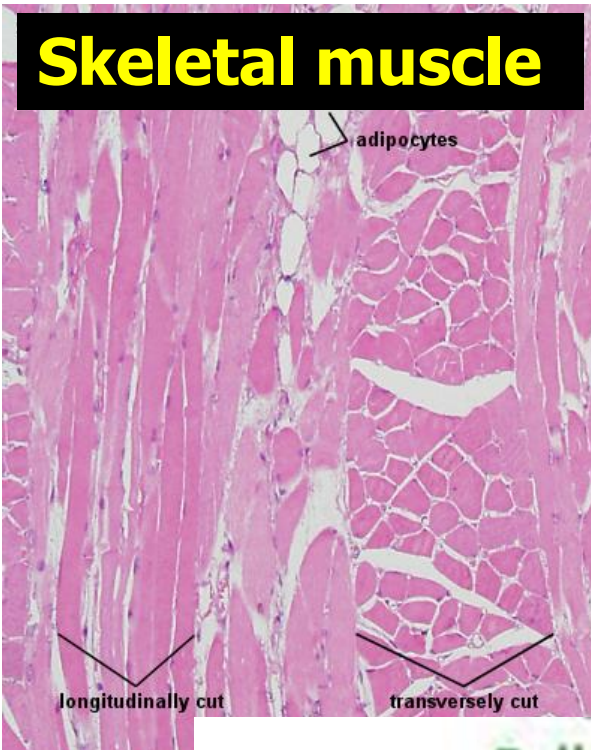
Urinary bladder wall



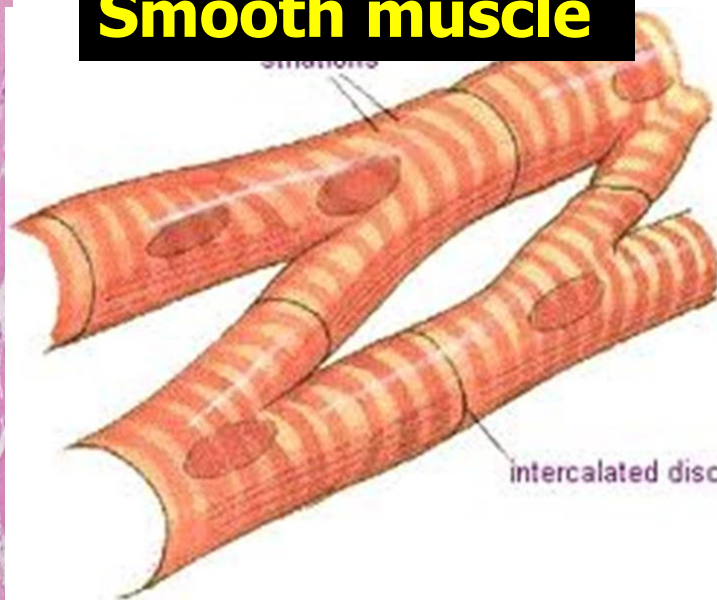
SUMMERY

SUMMARY

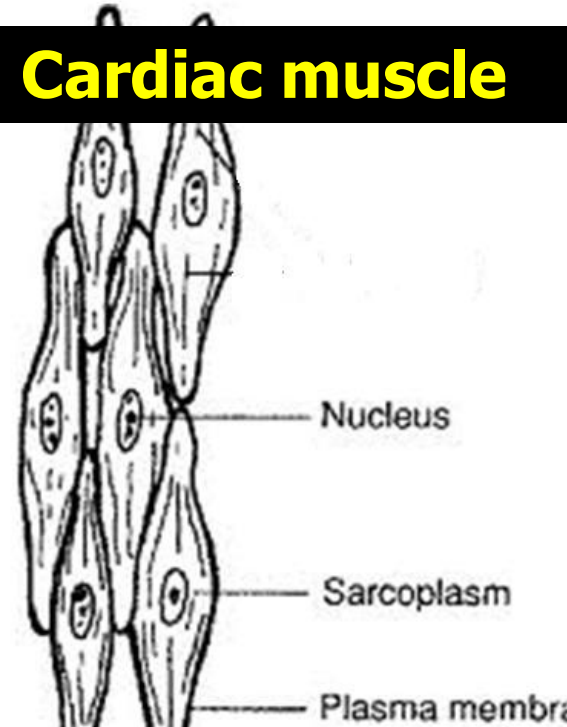
Skeletal muscle



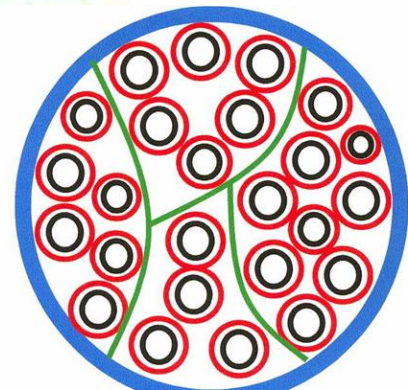
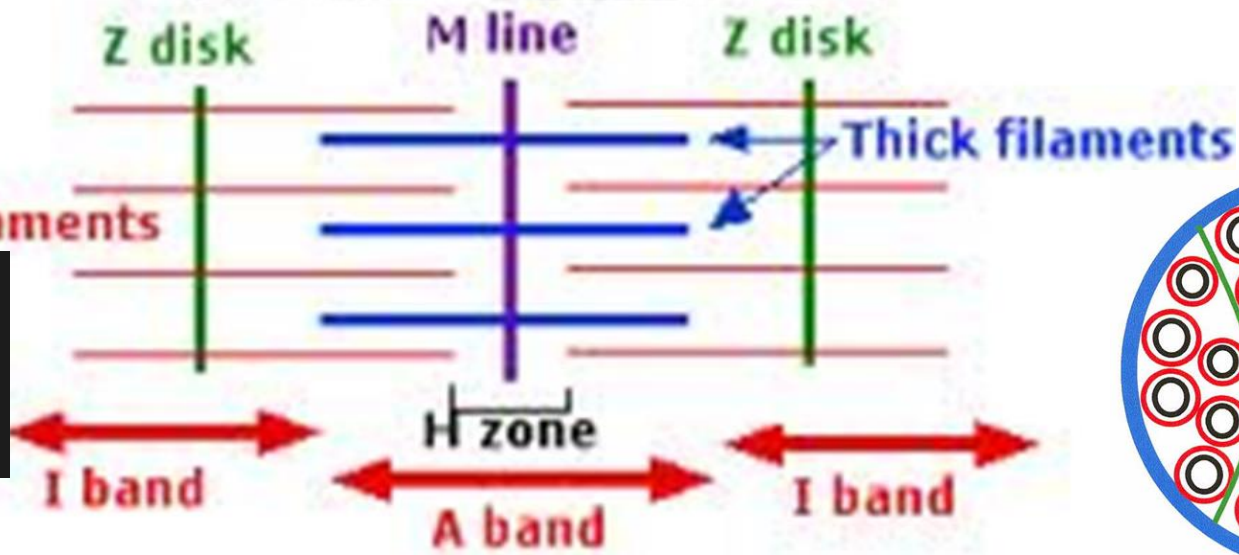
Smooth muscle



Cardiac muscle



Contractile unit



REFERENCES

- Burkit, H.G, young, B. (1993). **Wheaters functional histology**. 4 th ed., london:Churchill livingstone
- **Junqueira, L.C., Carneiro (1998). Basic histology**. 9 th ed., stamford: Appleton & lange

