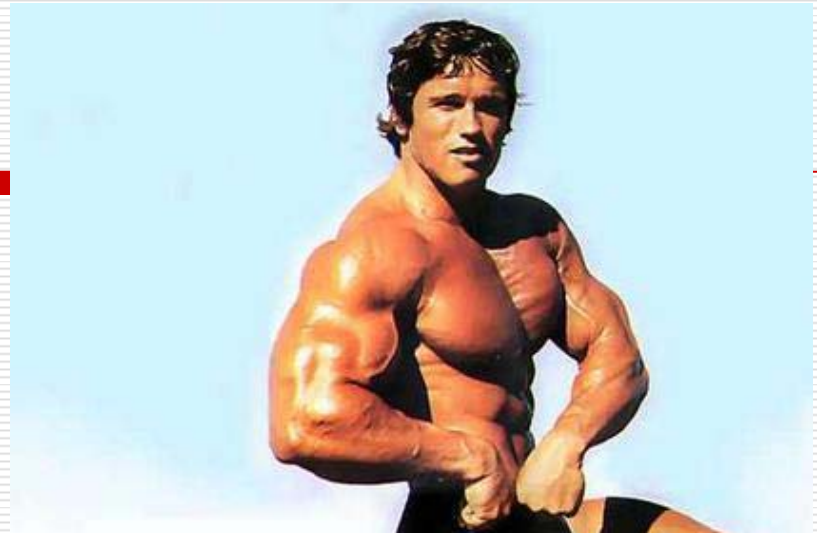


Chapter 7



Muscle Tissue

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muscular cells and less connective tissue
between the cells

muscle fiber, sarcolemma

Sarcoplasm, sarcoplasmic reticulum

Classification: skeletal muscle, cardiac
muscle(striated muscle) and smooth
muscle

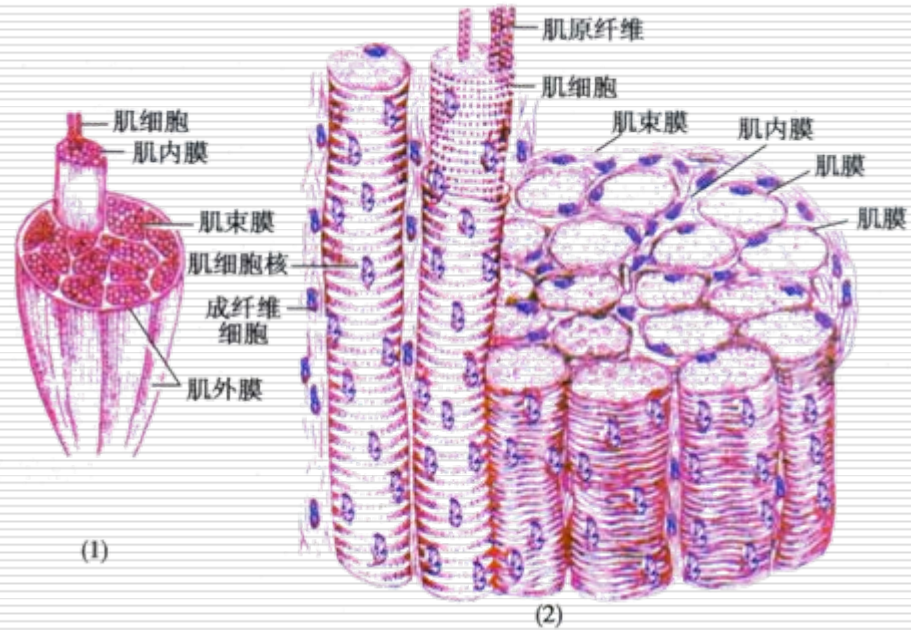
I .Skeletal muscle

Epimysium

Perimysium

Endomysium

Muscle satellite cell (stem cell)



1. General structure of skeletal muscle

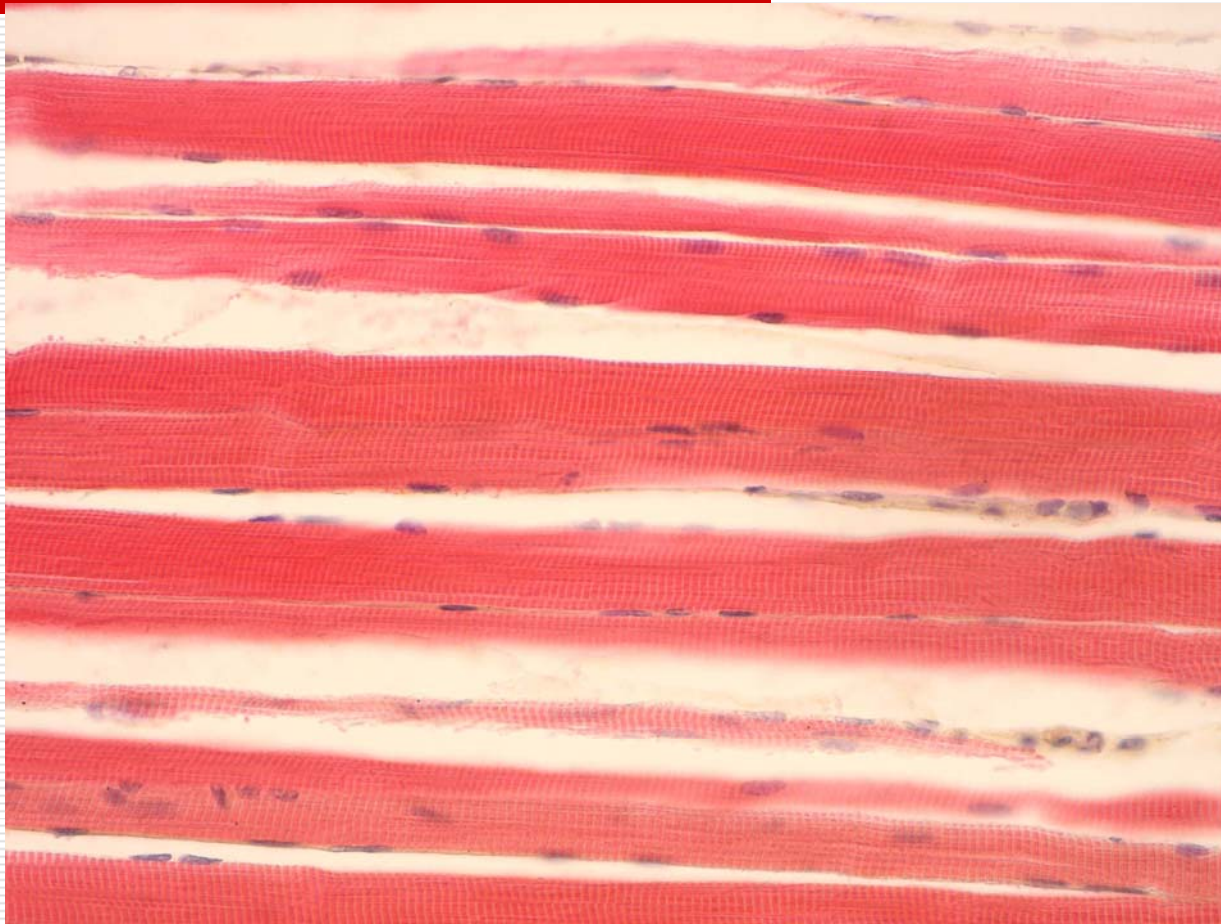
LM: long cylinder shape cell

long: 1 ~ 40 mm, multinucleated cell, oval nuclei located under the sarcolemma, pale staining, Basement membrane

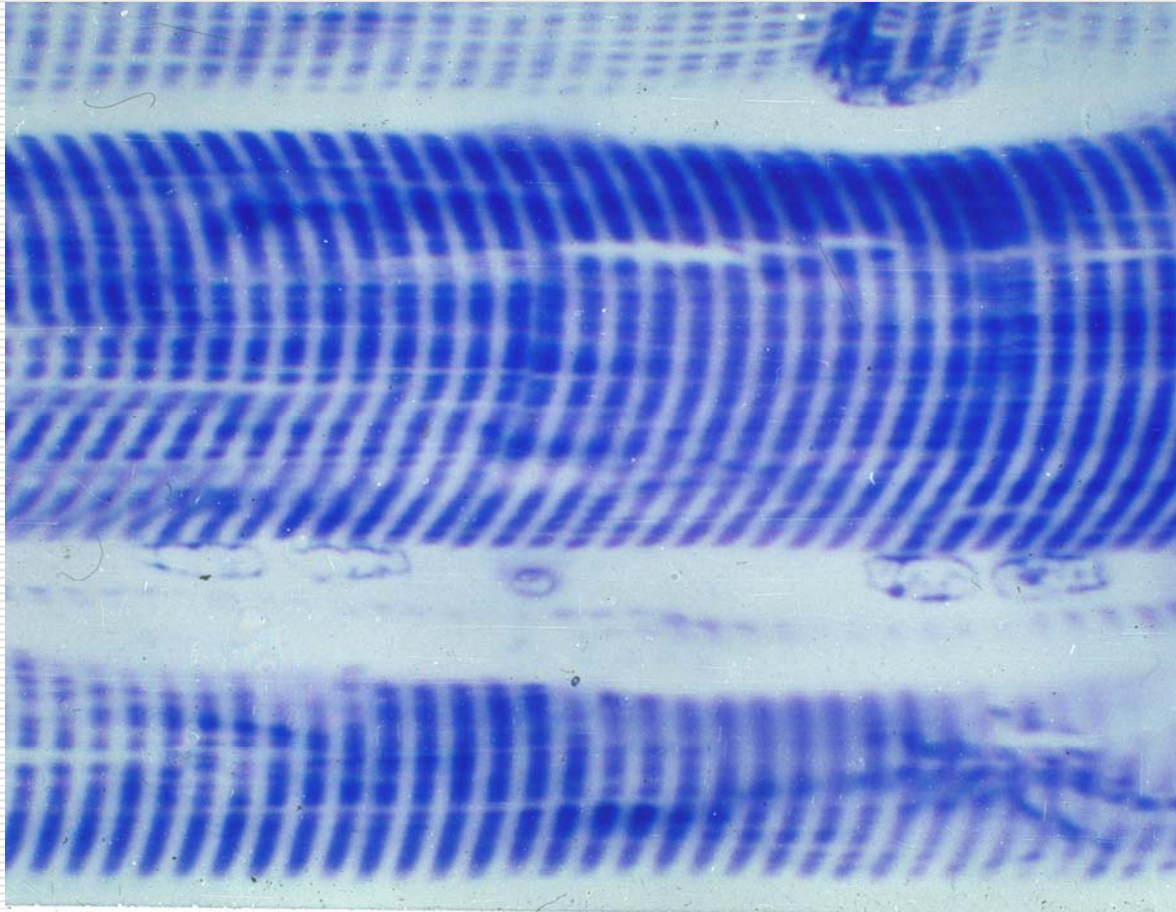
Myofibril : cross-striation of alternating light and dark bands

Skeletal muscle

(longitudinal section, LM)



Skeletal muscle (specific staining)



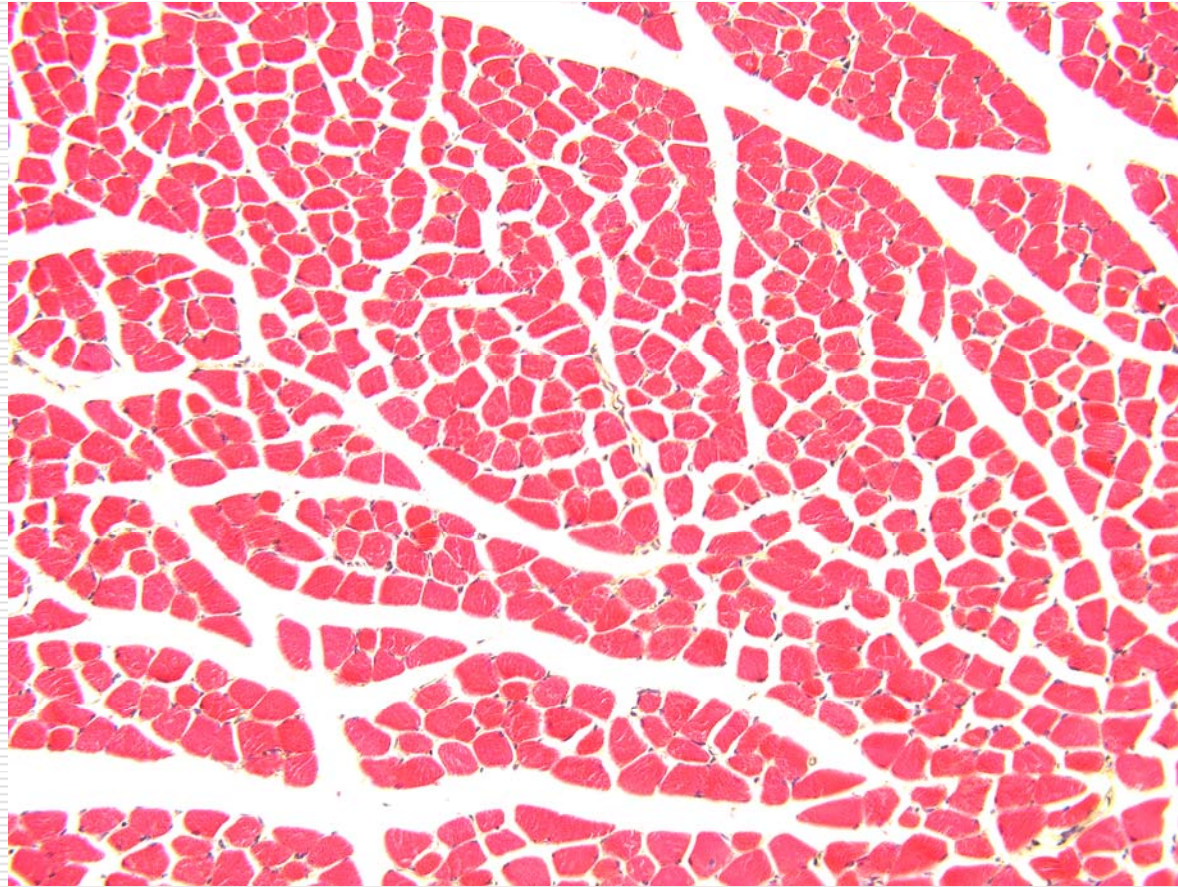
light band, isotropic (各向同性) ,

so called I band

dark band, anisotropic, (各向异性)

so called A band

Skeletal muscle (transverse section, LM)



2. Ultrastructure of skeletal muscle

2.1 Myofibril

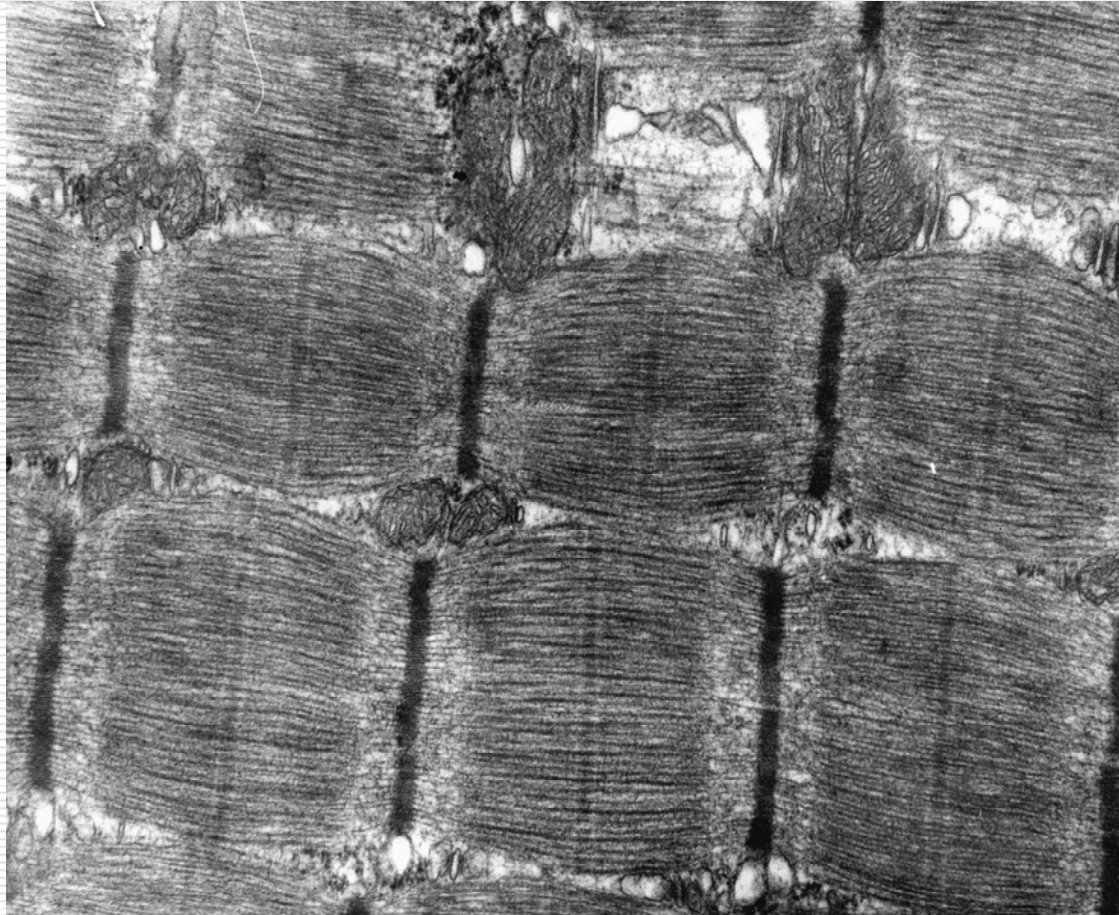
H band: center of dark band

M line: center of H band

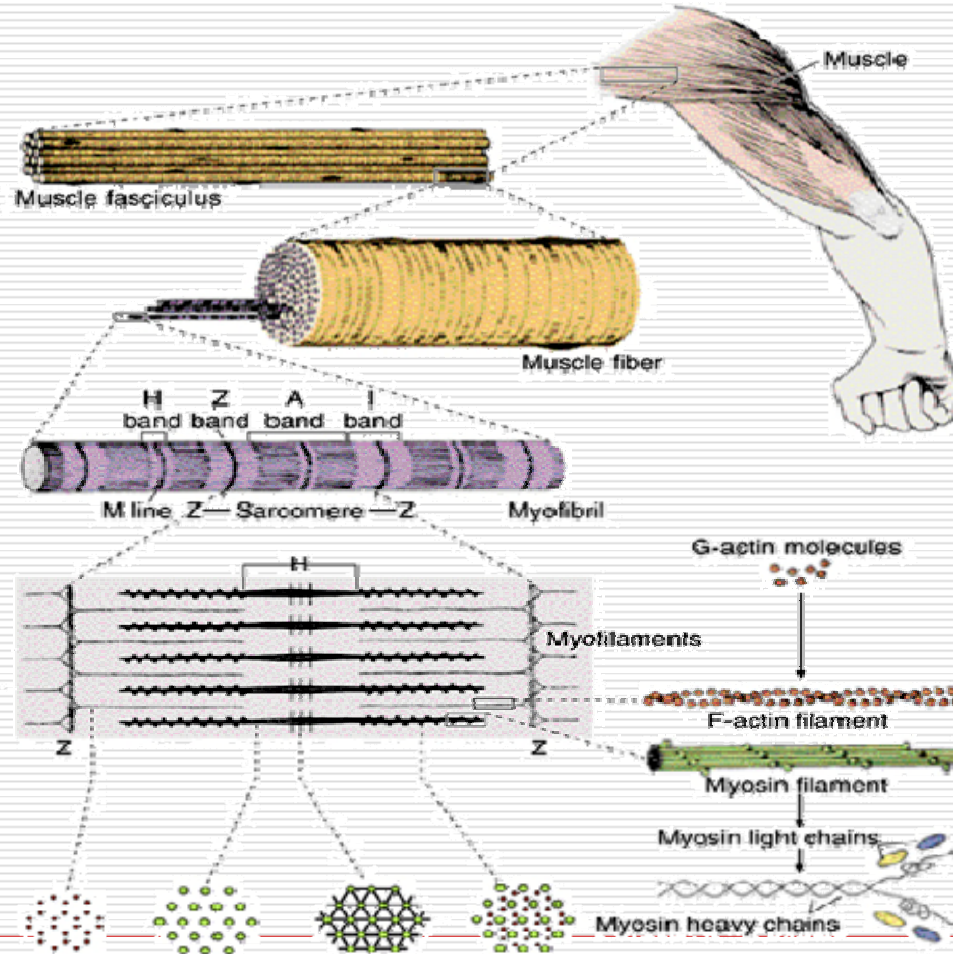
Z line: center of light band

Sarcomere extends from Z line to Z line in the myofibril, including $\frac{1}{2}$ light band + dark band + $\frac{1}{2}$ light band

Skeletal muscle fiber (TEM)



Ultrastructure and molecular structure of muscle fiber



□ myofibril consists of thick and thin filaments, two kinds of filaments regular arrange.

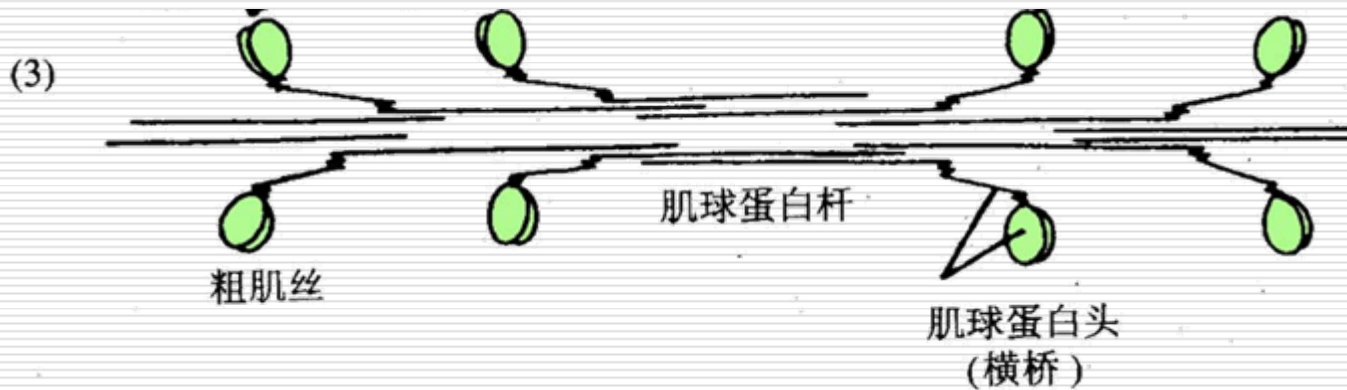
Thick filaments are fixed on M membrane.

Thin filament are fixed on Z membrane.

(1) Thick myofilament (myosin)

Molecular structure of myosin:

Cross bridge (ATP enzyme)



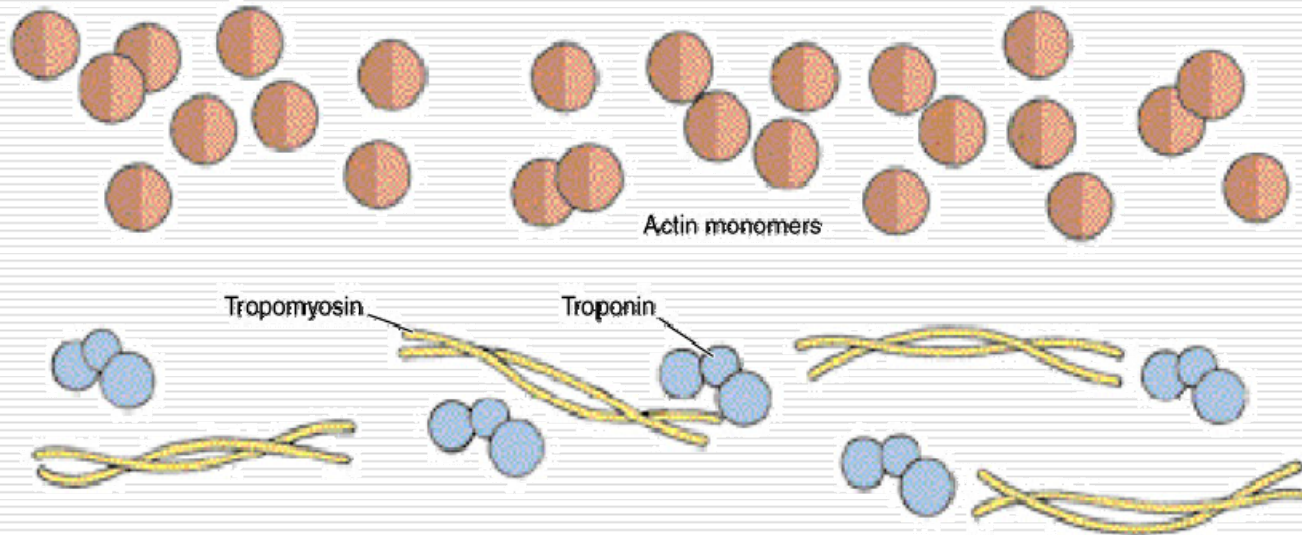
(2) Thin myofilament

- ① Actin
- ② tropomyosin
- ③ troponin

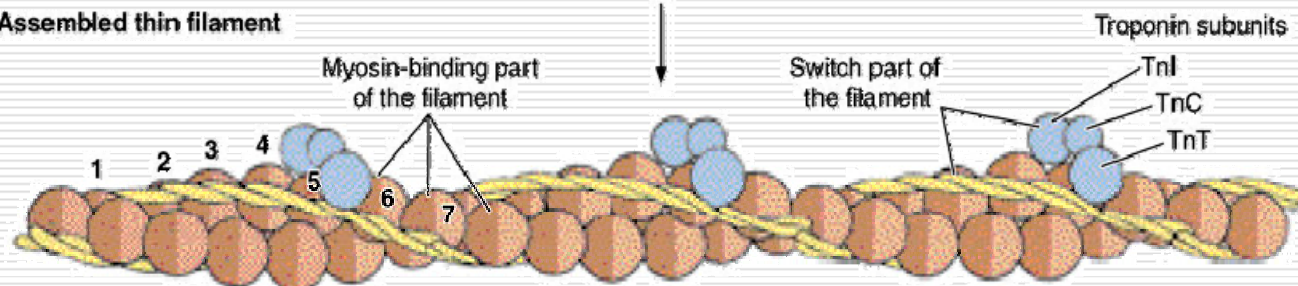


Molecular structure of thin filament

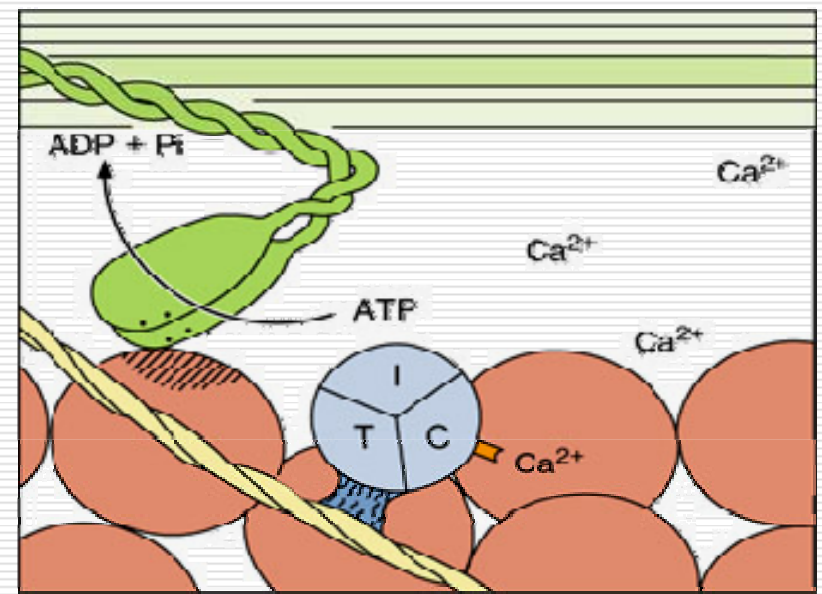
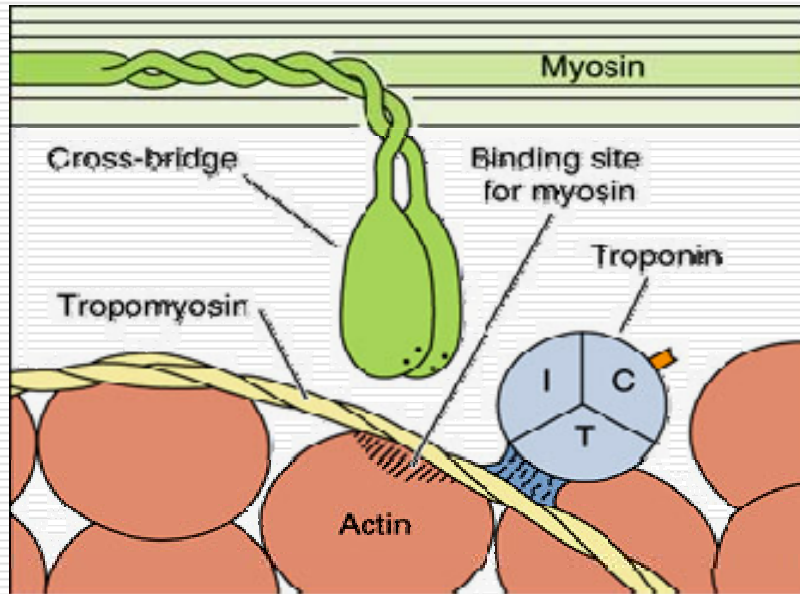
Disassembled components of the thin filament



Assembled thin filament



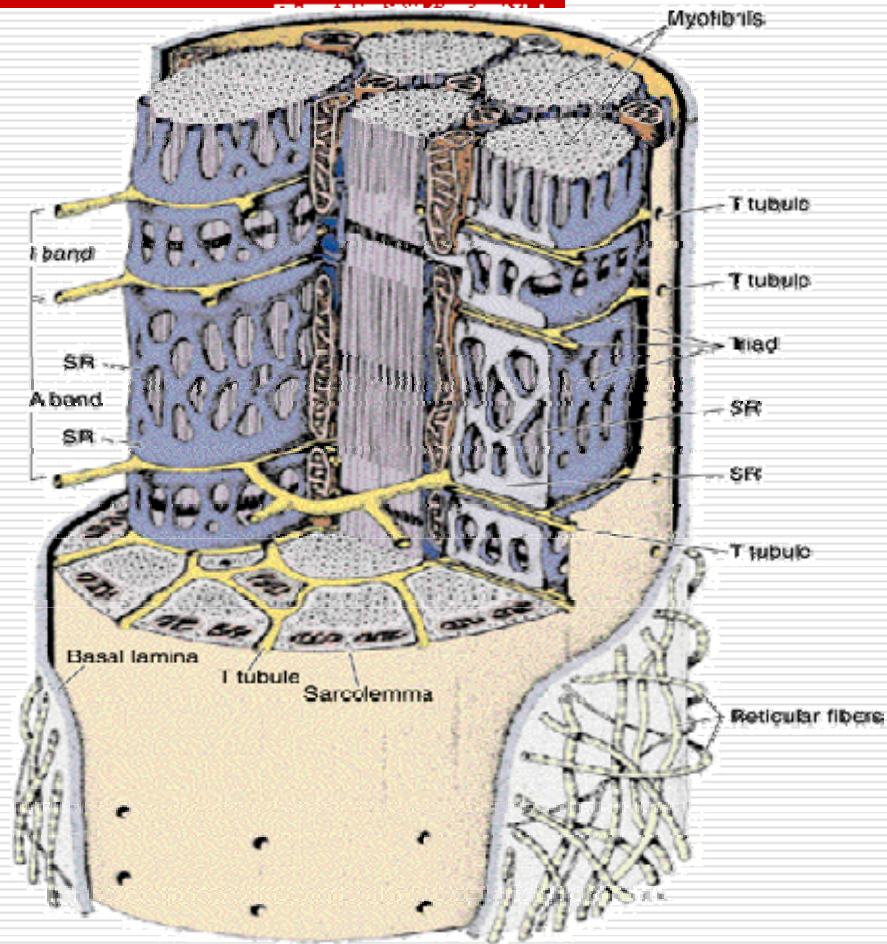
Contractile principle of skeletal muscle fiber



2.2 Transverse tubule

- So called T tubule, these fingerlike invaginations of sarcolemma form a complex network of tubules that encircle the boundaries of the A-I bands of each sarcomere in every myofibril
-

Transverse tubule and sarcoplasmic reticulum (stereo model)



2.3 Sarcoplasmic reticulum (longitudinal tubule)

- So called L tubule, smooth endoplasmic reticulum in muscular fiber
- terminal cisterna
- triad: transverse tubule and adjacent two terminal cisternae

Function: to adjust the level of Ca^{2+}

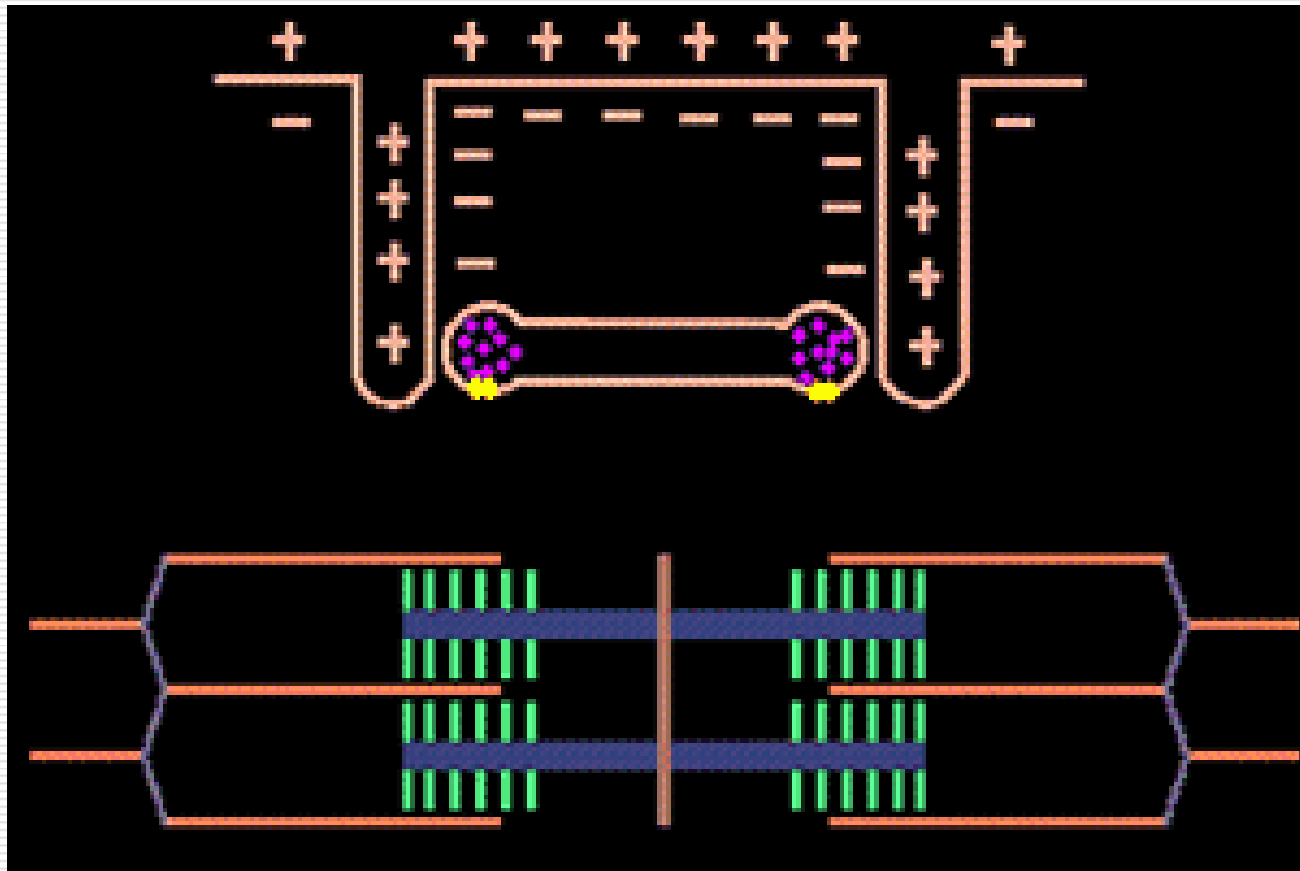
2.4 Mitochondria

Glycogen granule

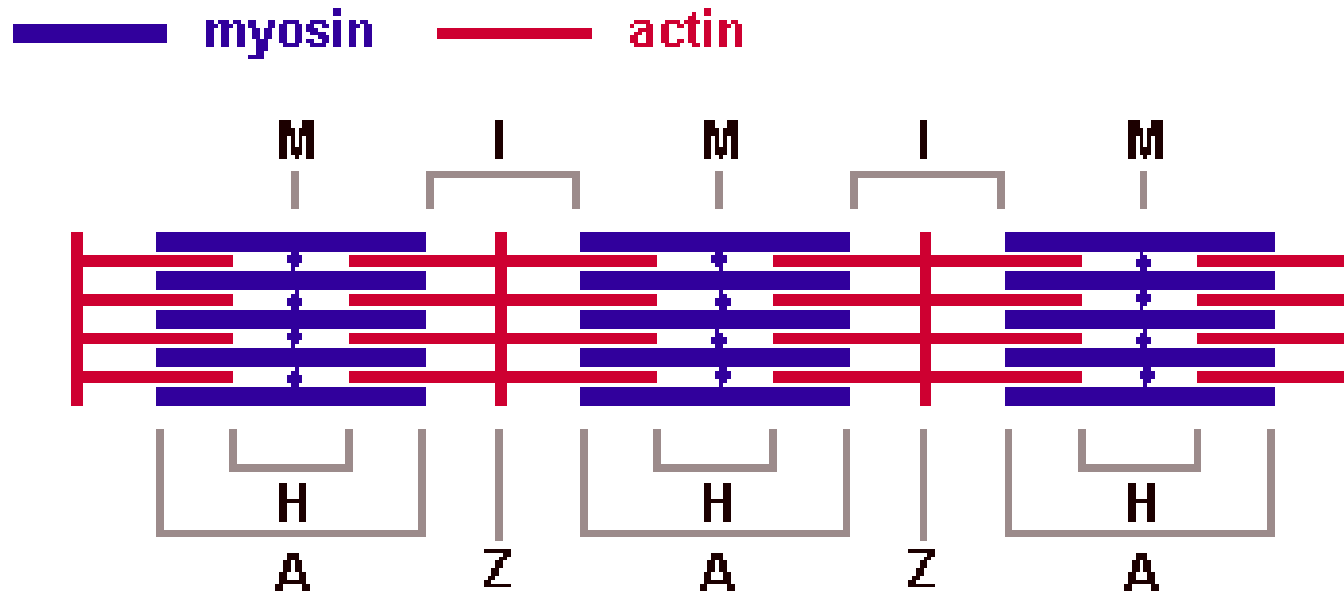
Less adipose droplet

Myoglobin

Transverse tubule and sarcoplasmic reticulum



Contraction of Sarcomere



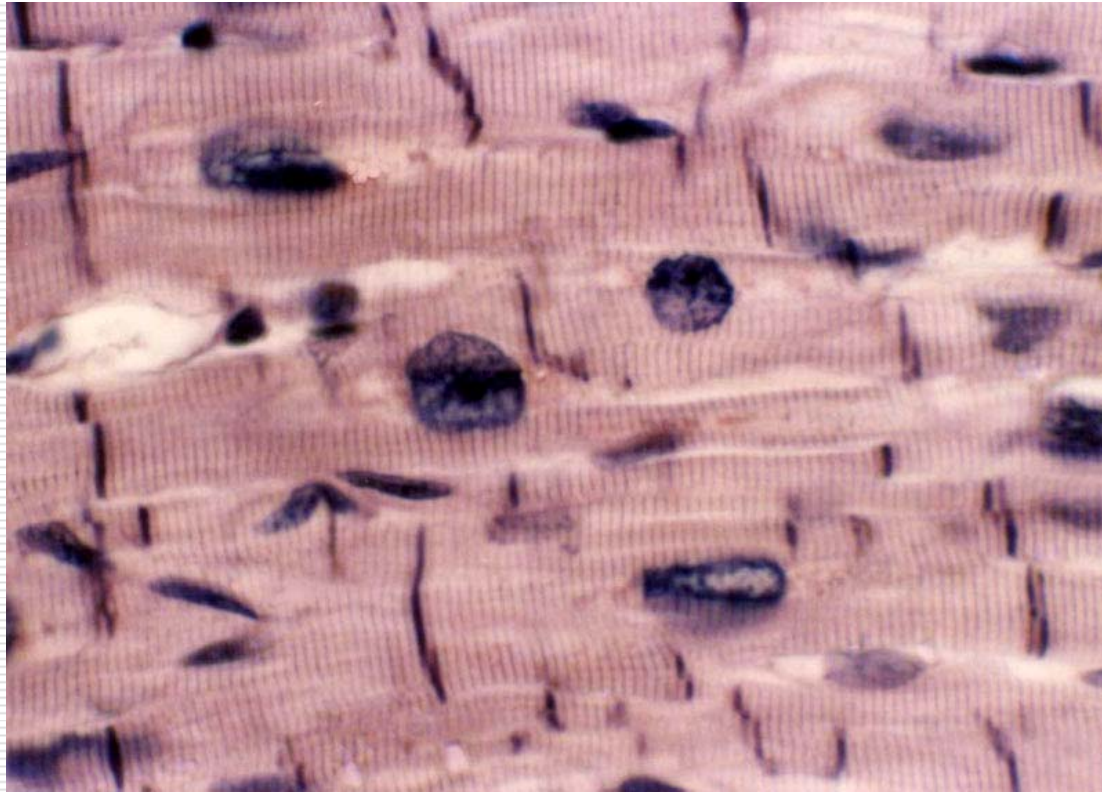
Bands and lines in the contractile apparatus of skeletal muscle

II. Cardiac muscle

1. General structure of cardiac muscle

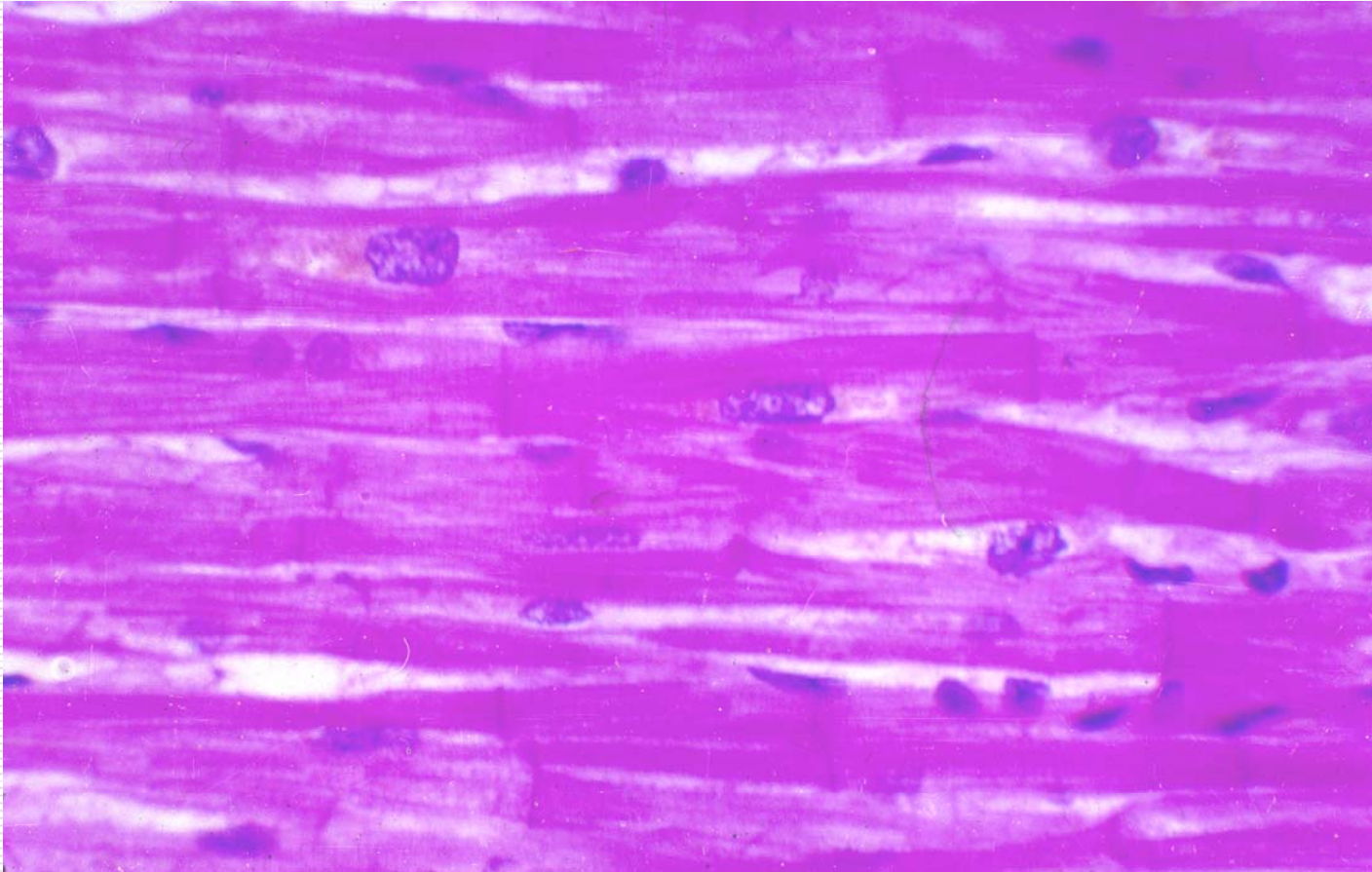
LM: shorter cylinder shape and branched cardiac muscle cell , only one centrally located pale-staining nuclei, less myofilaments in the cytoplasm surrounded by nuclei, a rich capillary network surrounding the cells

Cardiac muscle fiber (Intercalated disk) (Hemalum staining)



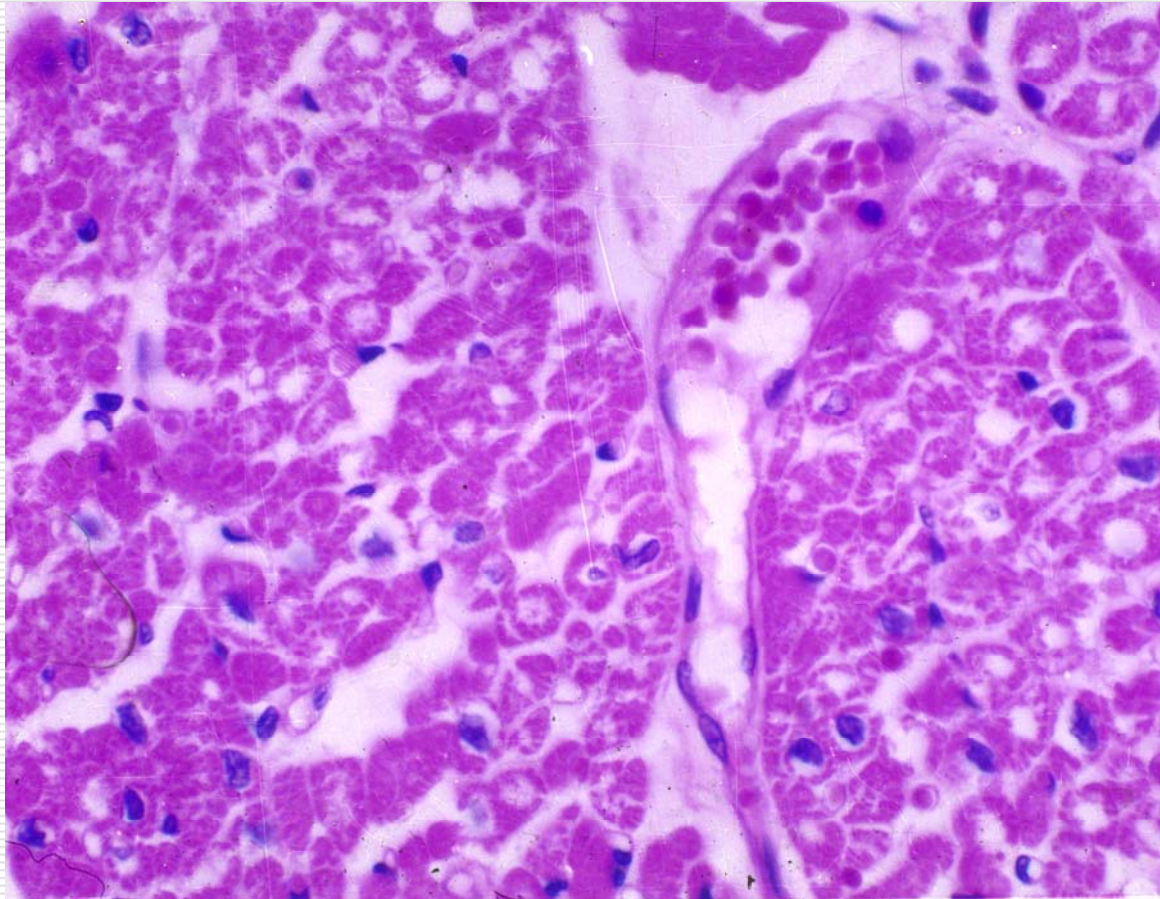
Cardiac muscle fiber

(longitudinal section, LM)



Cardiac muscle fiber

(transverse section, LM)



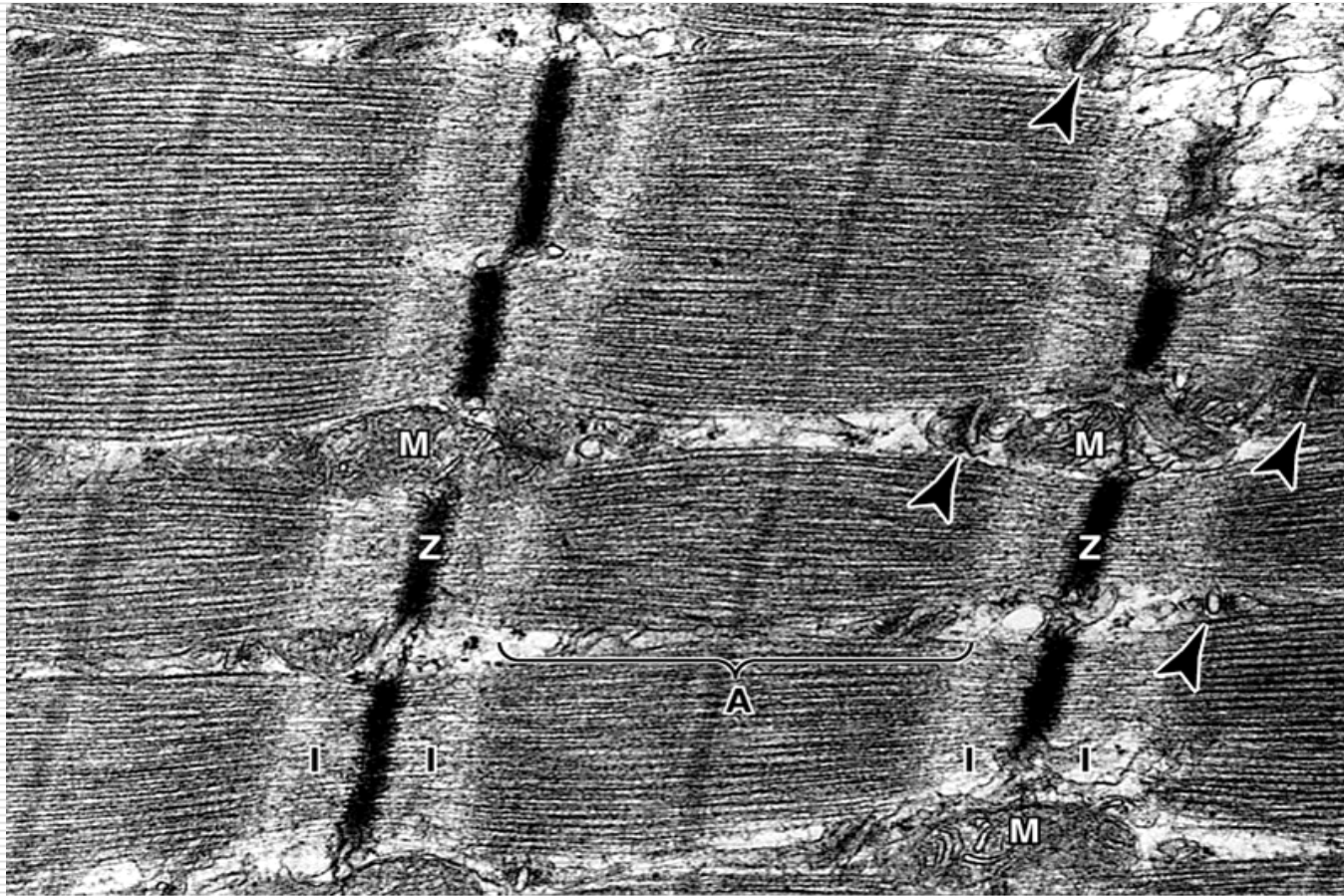
Intercalated disk:

Dark staining transverse lines
between adjacent cardiac muscle
cells

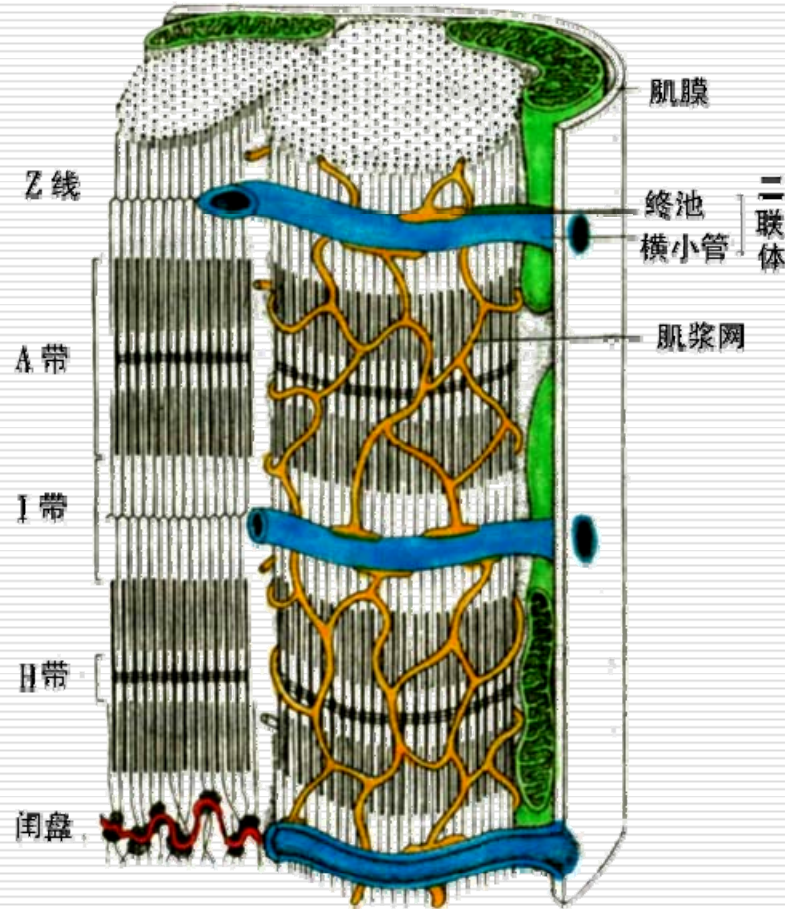
2. Ultrastructure of cardiac muscle cell

Similar points: thick filament, thin
filament and sarcomere

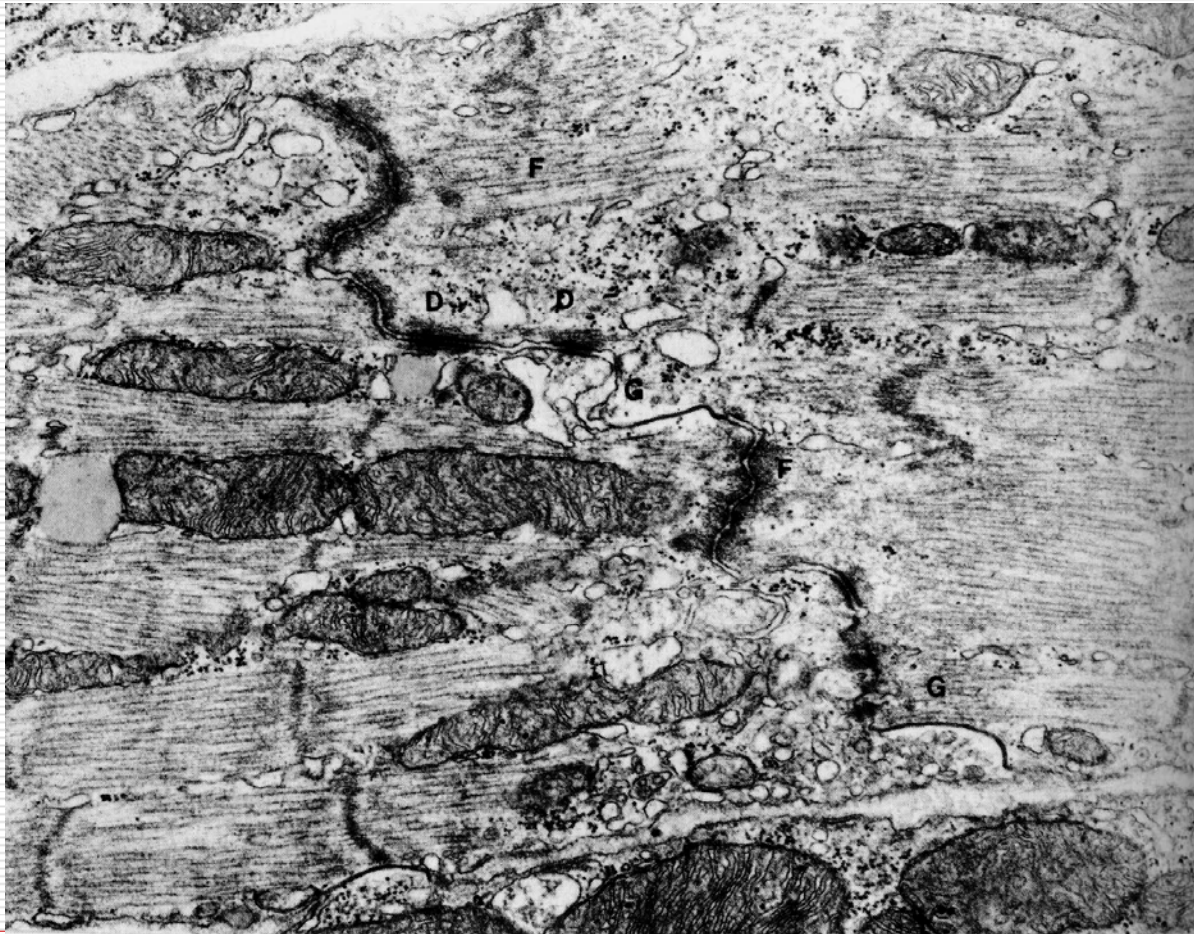
Cardiac muscle fiber (TEM)



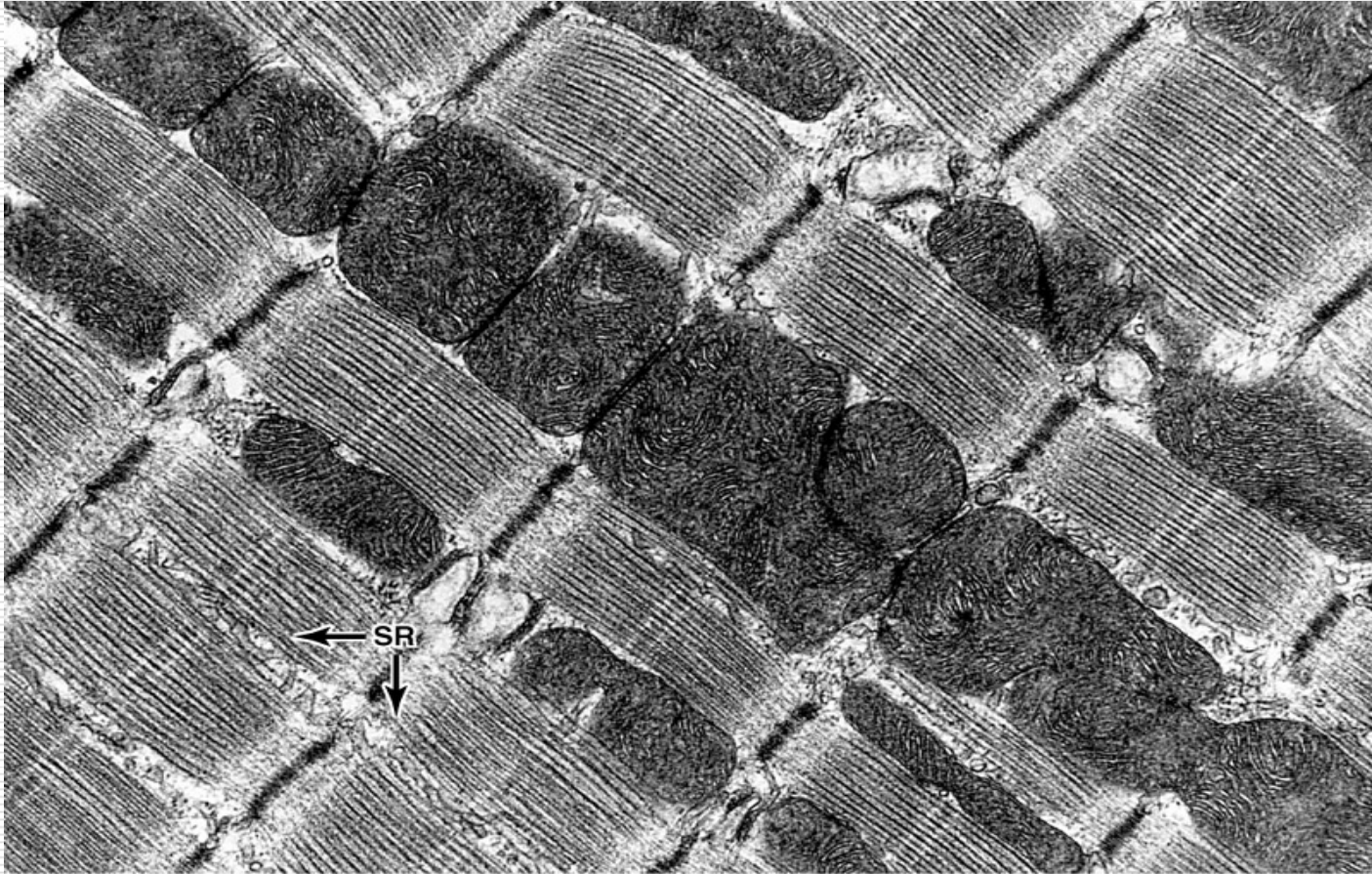
Ultrastructure of Cardiac muscle fiber (model)



Intercalated disk (TEM)



Mitochondria in cardiac muscle fiber (TEM)



□ Different points:

2.1 Myofibril bundles

2.2 Thick T tubule (Zline level)

2.3 Undevelopment terminal cisternea (diad)

2.4 Intercalated disk (Z line level)

transverse position:

intermediate junction and desmosome

longitudinal position: gap junction

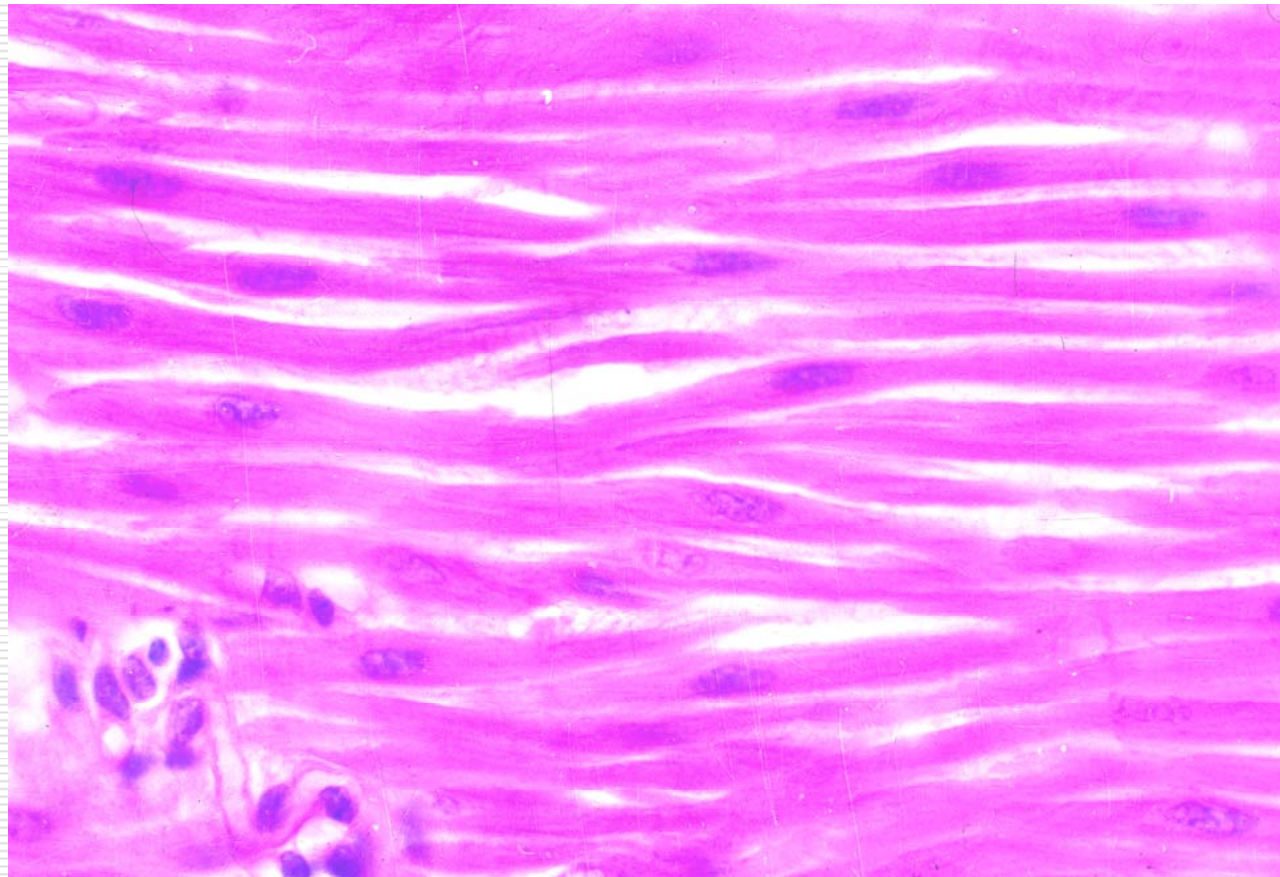
Very large and rich mitochondria
(glycogen granules and adipose droplet)

III. Smooth muscle

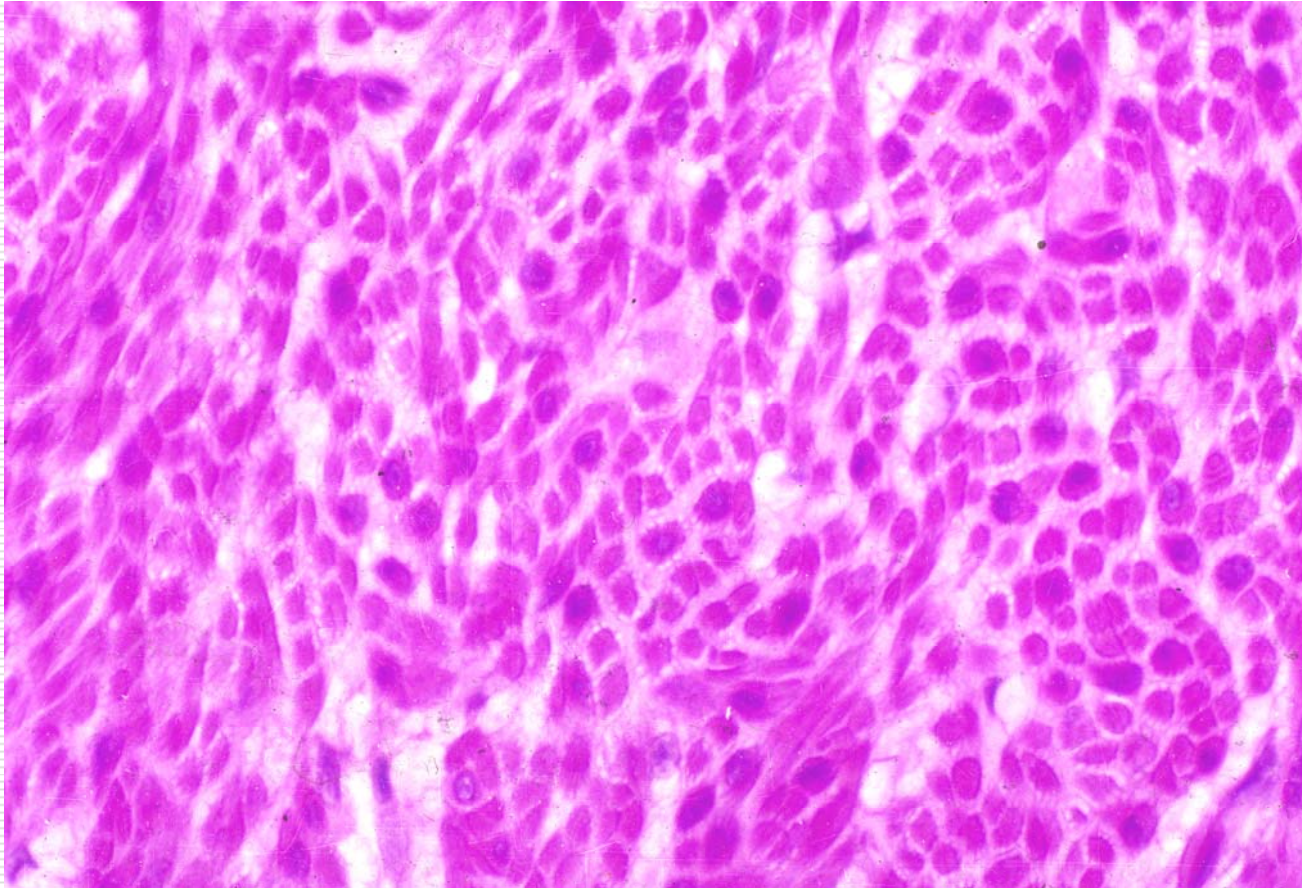
1. General structure of smooth muscle

LM: Longer spindle shape cell, a single nucleus located in the center of cell (dark staining), eosinophilic and nonstriated cytoplasm

Smooth muscle fiber (longitudinal section, LM)



Smooth muscle fiber (transverse section, LM)



2.Ultrastructure of smooth muscle

TEM: ①dense patch

(equal to Z membrane)

attached thin filament on it

②dense body: intermediate filament between
dense area and dense body

③ caveola: formed by sarcolamma invagination
and open outer of the cell (equal to T tubule)

Smooth muscle fiber (TEM)



④ myofilament:

thick filament (enough concentration of A
T P、M g 2+、C a2) ,myosin

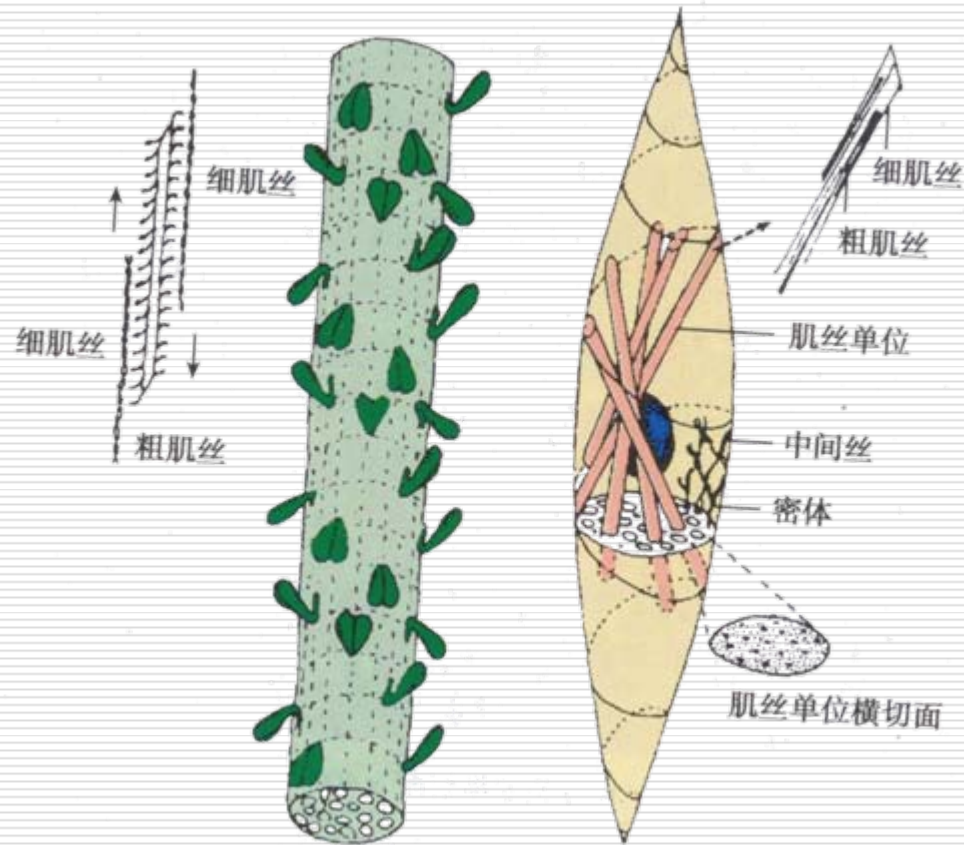
thin filament: actin

myofilament unit (contractile unit)

Golgi complex, free ribosome and

glycogen granules

Contractile unit of smooth muscle fiber (model)

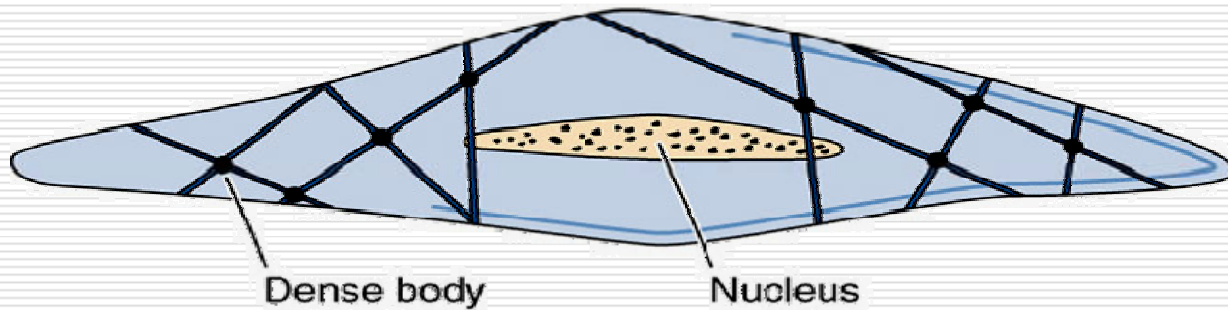


Function of smooth muscle cell:

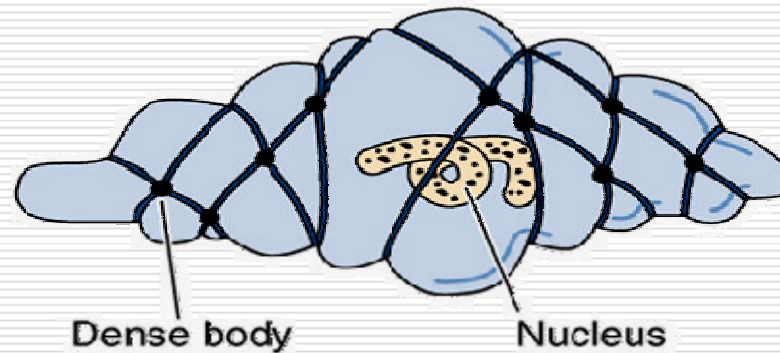
- ❑ Contraction
 - ❑ Synthesis of collagenous fiber elastic fiber and ground substance
 - ❑ Contractile principle of smooth muscle
-

Contraction of smooth muscle fiber (model)

Relaxed smooth muscle cell



Contracted smooth muscle cell



Highlight of this chapter

- LM structure of three types of muscle fiber
 - Ultrastructure of skeletal muscle
 - What are ultrastructure difference of skeletal and cardiac muscle?
-