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# Muscular Tissue

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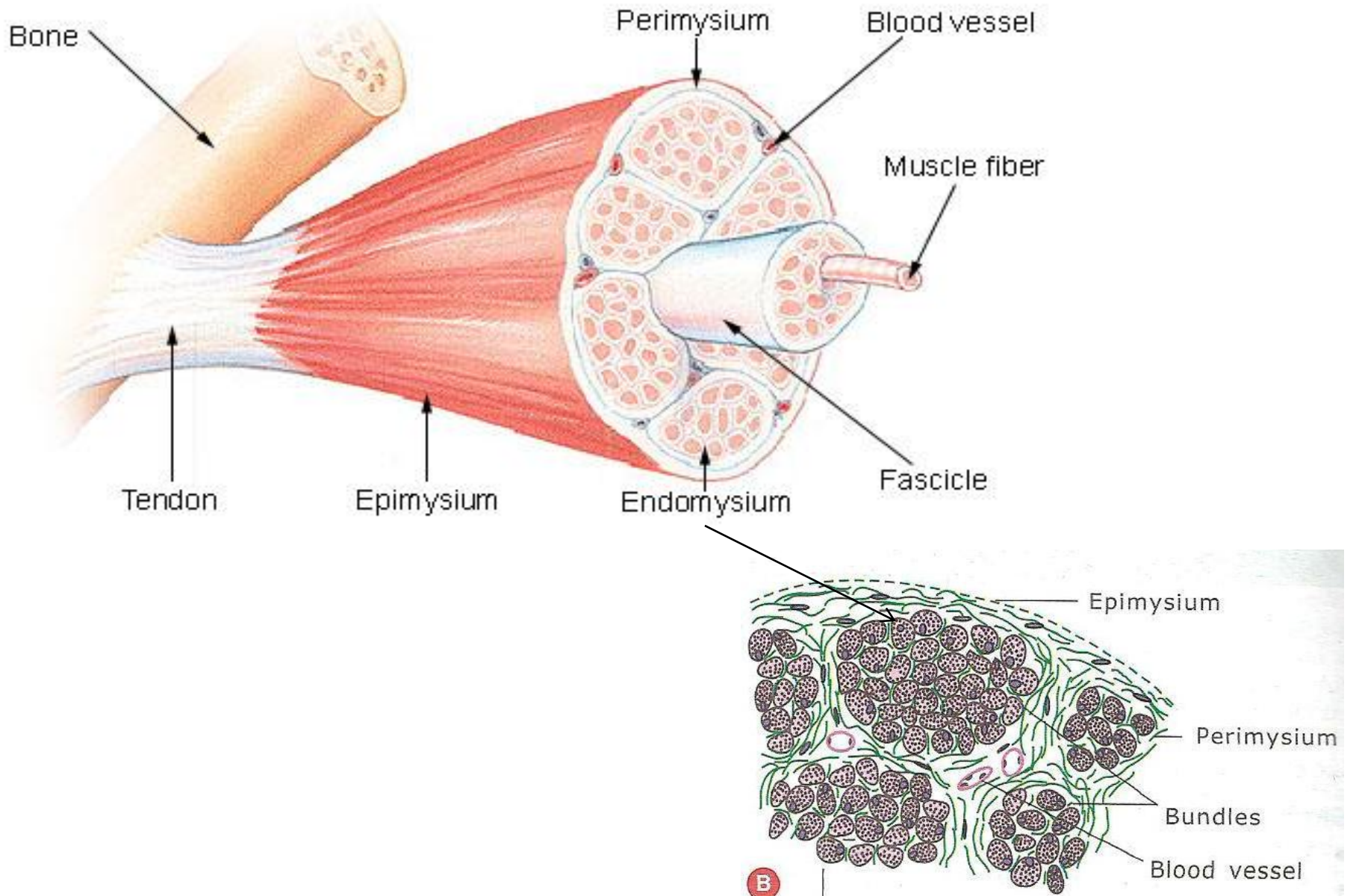
# What is Muscle Tissue?

- Composed of cells that are highly specialized to shorten in length by contractility.
- Made up of cells that are called myocytes.
- Elongated in one direction (muscle fibres).
- Histologically, it is of 3 types:
  - (i) Skeletal muscle
  - (ii) Cardiac muscle
  - (iii) Smooth muscle

# Skeletal Muscle

- Striated or voluntary muscle
- Present mainly in limbs and in relation to body wall
- Supplied by somatic division of nervous system
- Formed by fusion of multiple myoblasts during embryonic life
- Motor end plate
- Mostly originate from somatic mesoderm

# Connective tissue frame work

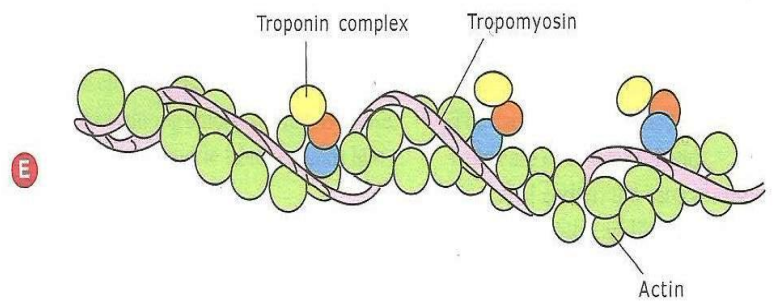
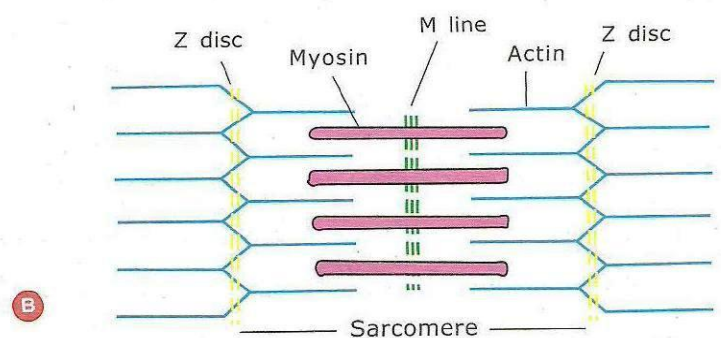
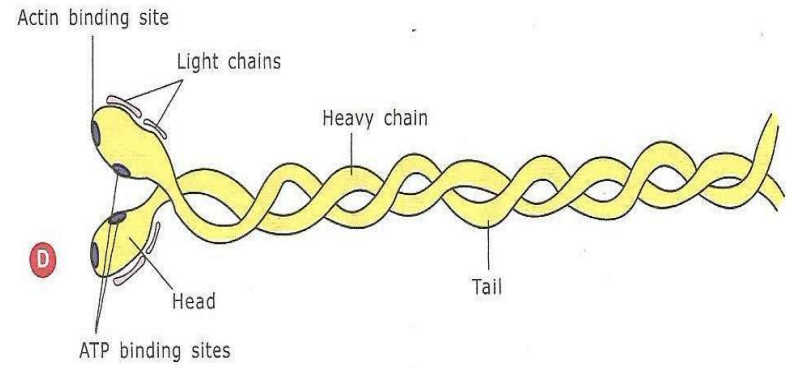
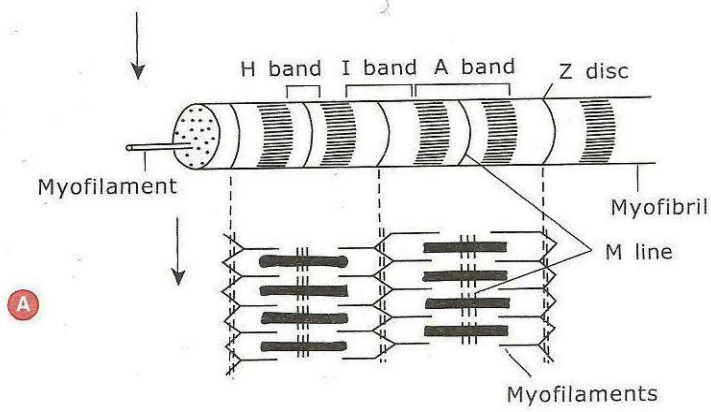
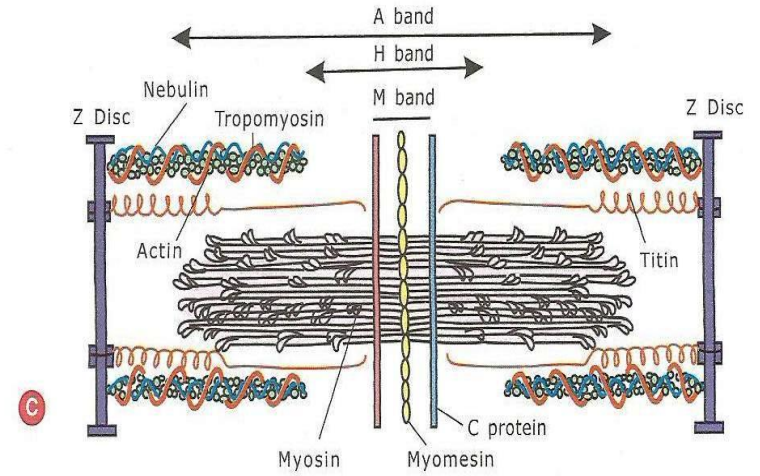
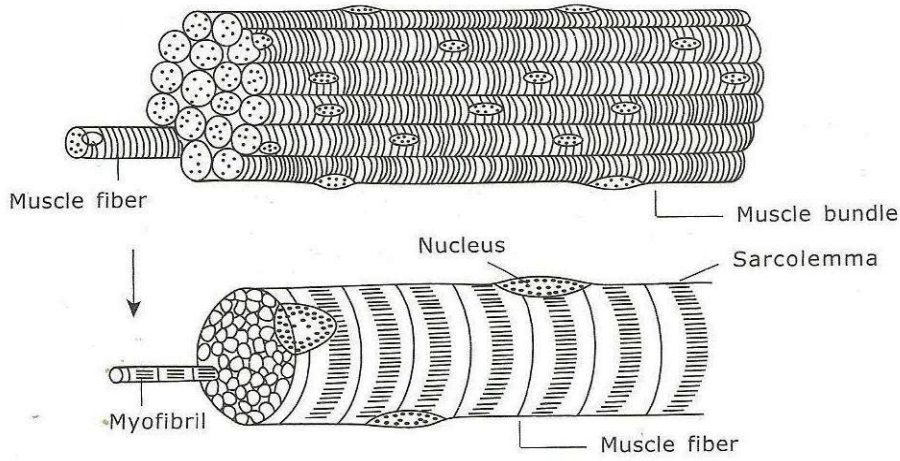


# Microscopic structure of Skeletal Muscle

- Fibres are arranged parallel to each other
- Basic unit is long, cylindrical fiber
- Alternate dark & light bands (cross-striations)
- Multinucleated, placed peripherally beneath the sarcolemma
- **Myofibrils:** contractile elements
- **Sarcomere:** fundamental contractile unit
- **Myofilaments:** contain thick (myosin) and thin (actin) filaments

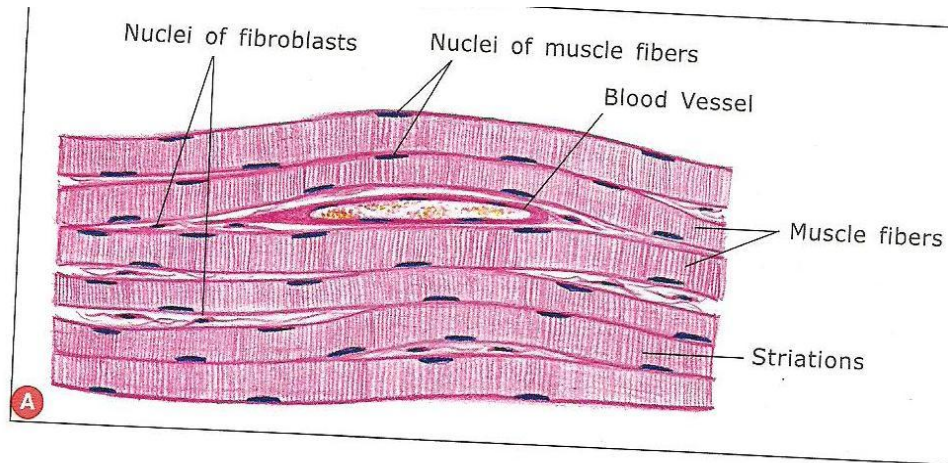
# Skeletal Muscle

- Each thick filament is surrounded by 6 thin filaments in hexagonal fashion
- Accessory proteins necessary for proper contraction: Titin, alpha actinin, nebulin, tropomodulin, dystrophin
- **Nerve supply:**
  - Motor fibres
  - Sensory fibres

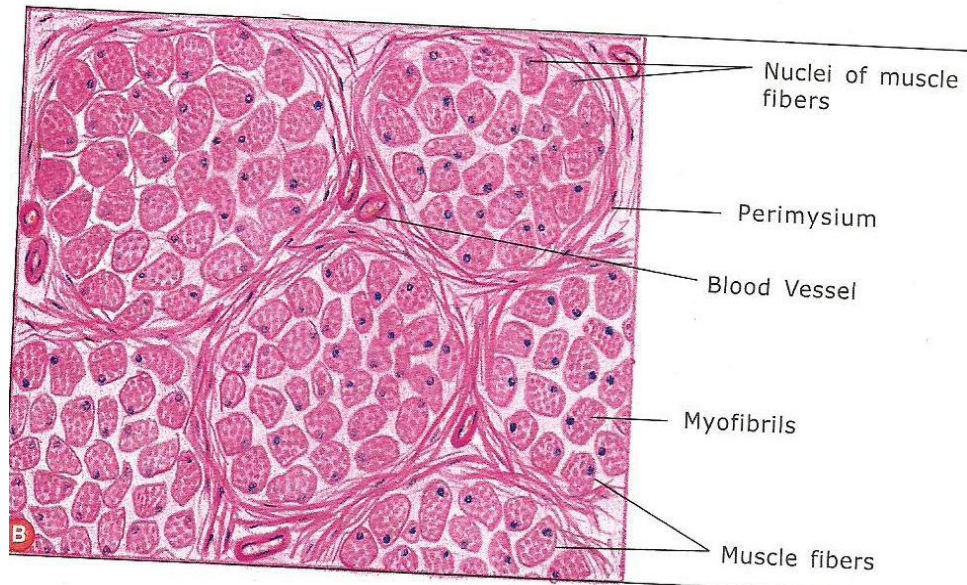




# Section of Skeletal muscle



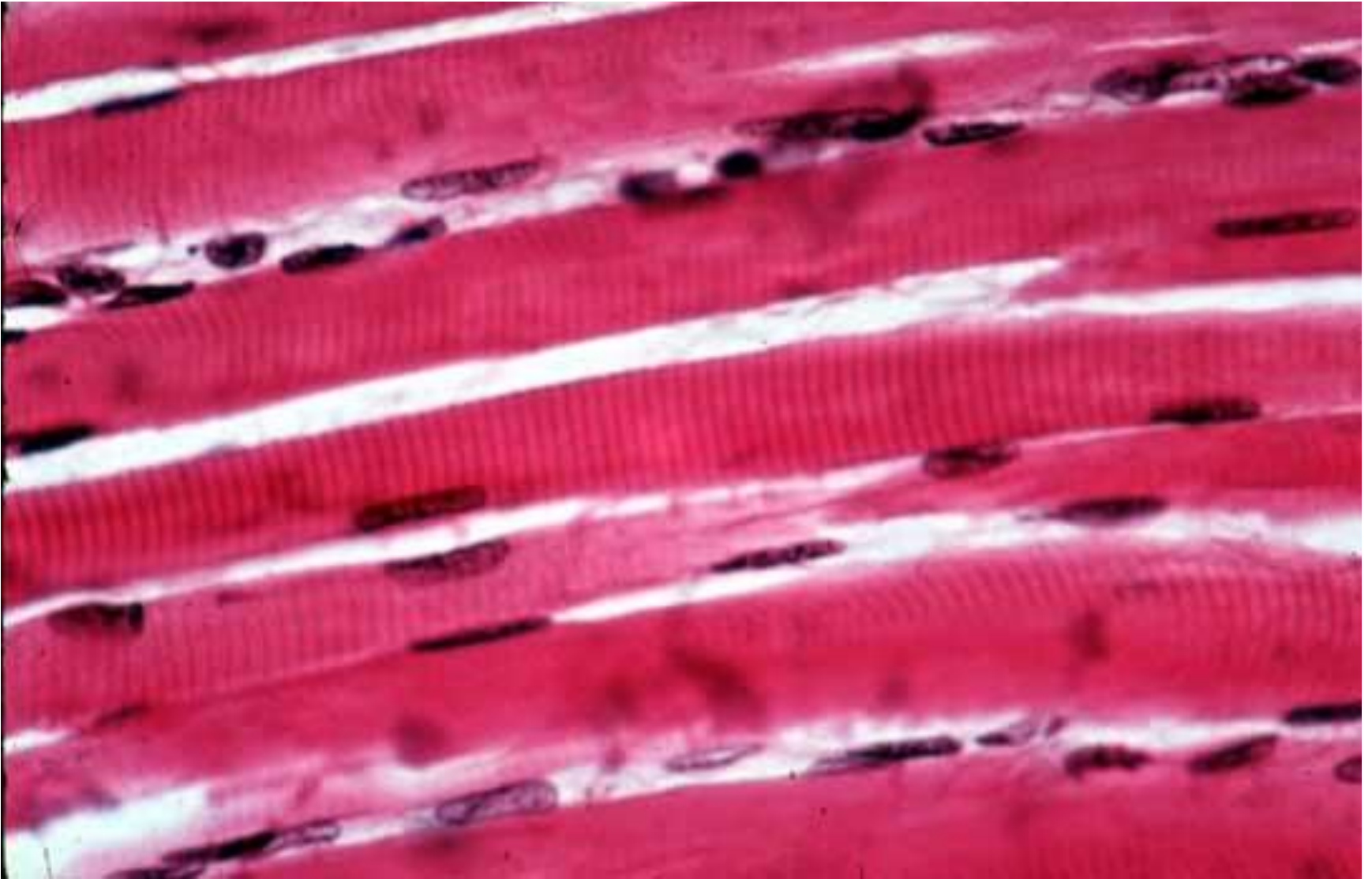
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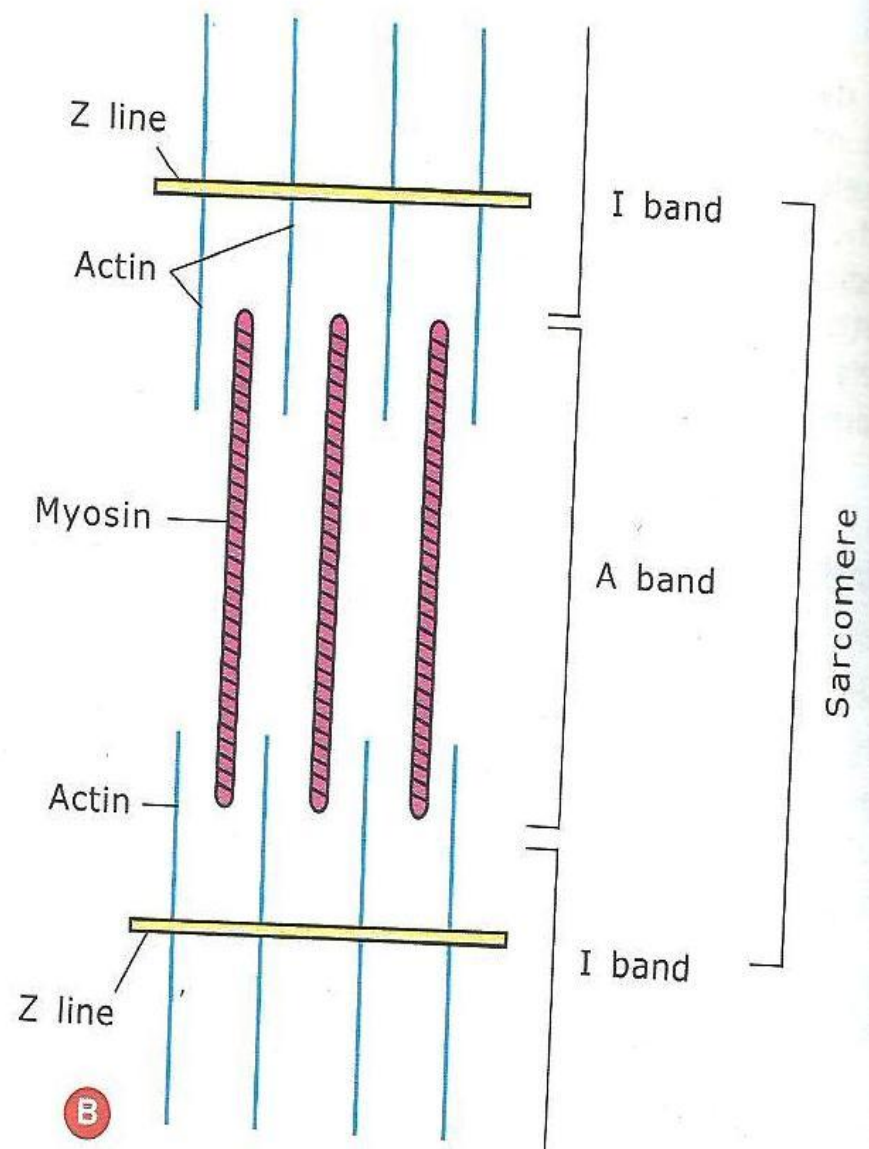
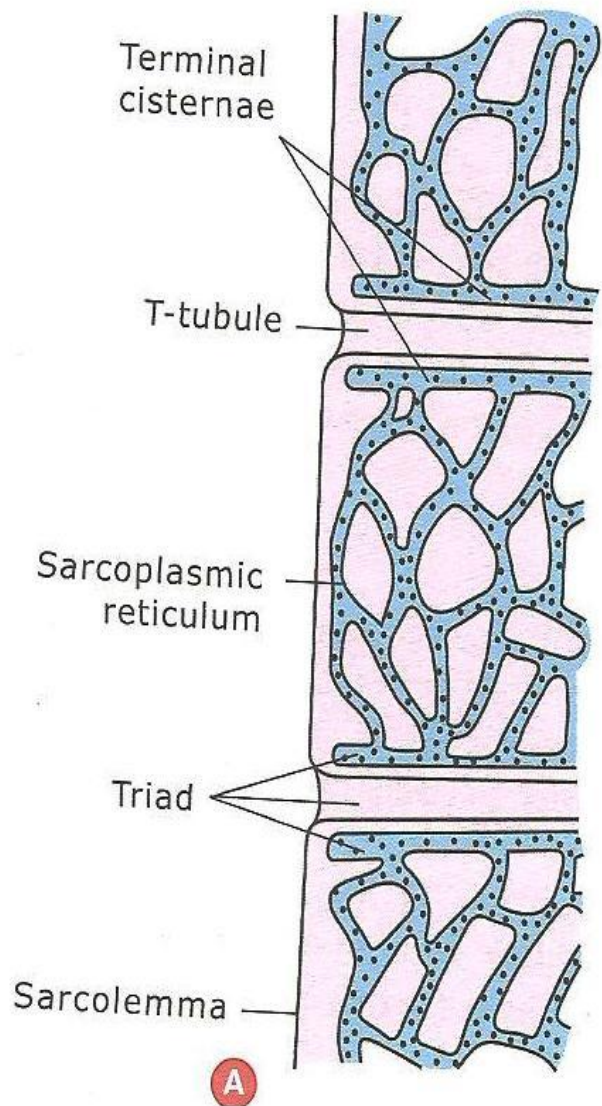


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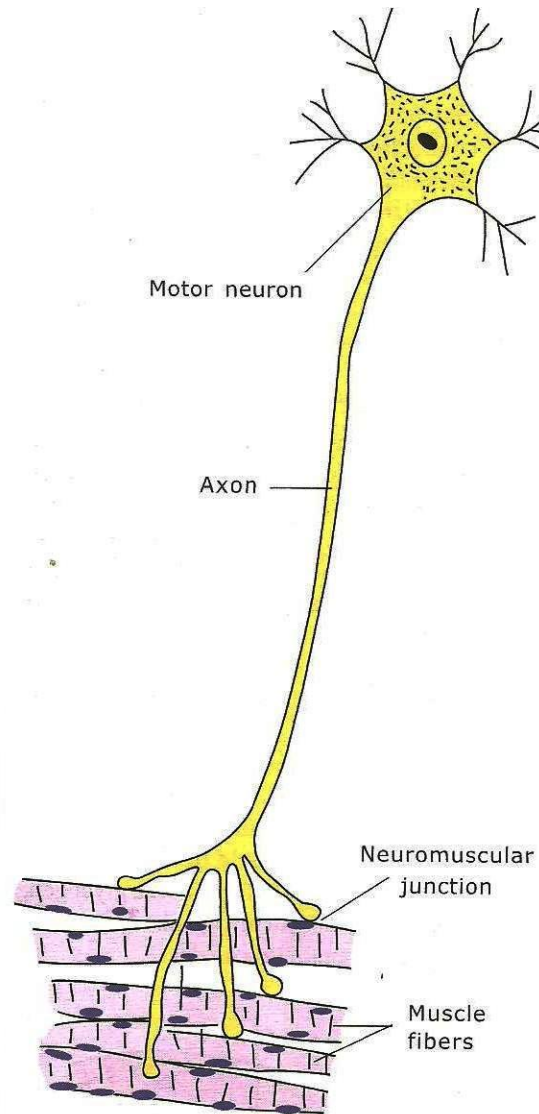


# Longitudinal Section of Skeletal muscle





# Motor Unit



# Clinical Application

- Duchenne Muscular Dystrophy (DMD)
- Rigor Mortis
- Myasthenia Gravis
- Neurotoxins
- Hypertrophy and Atrophy
- Regeneration

# Cardiac Muscle

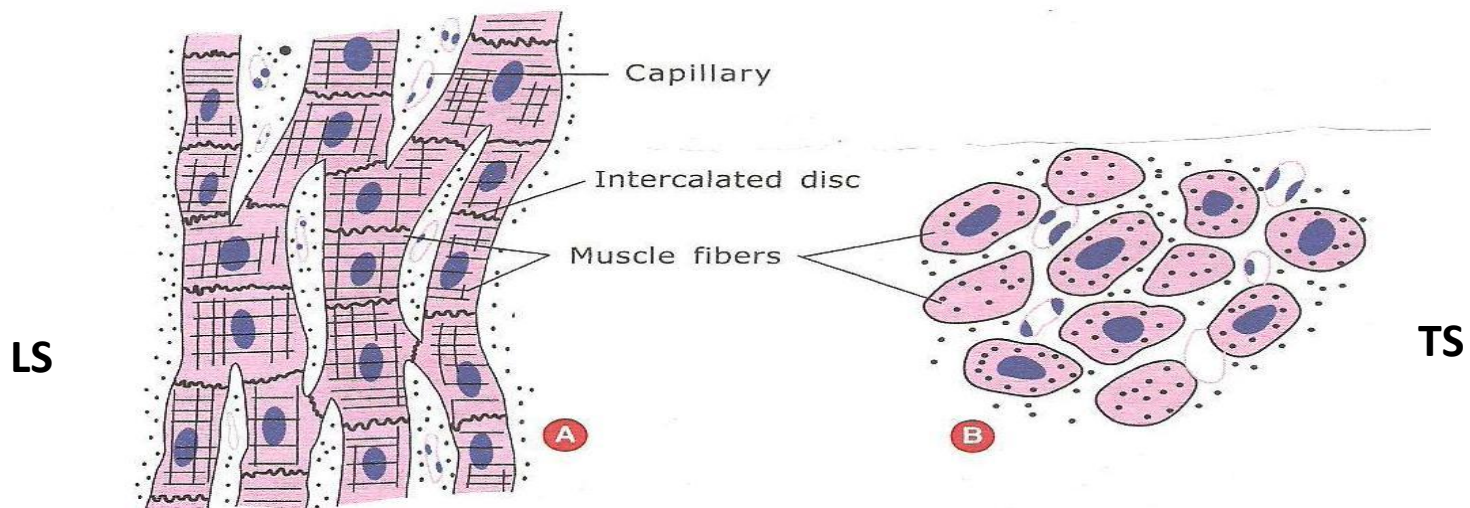
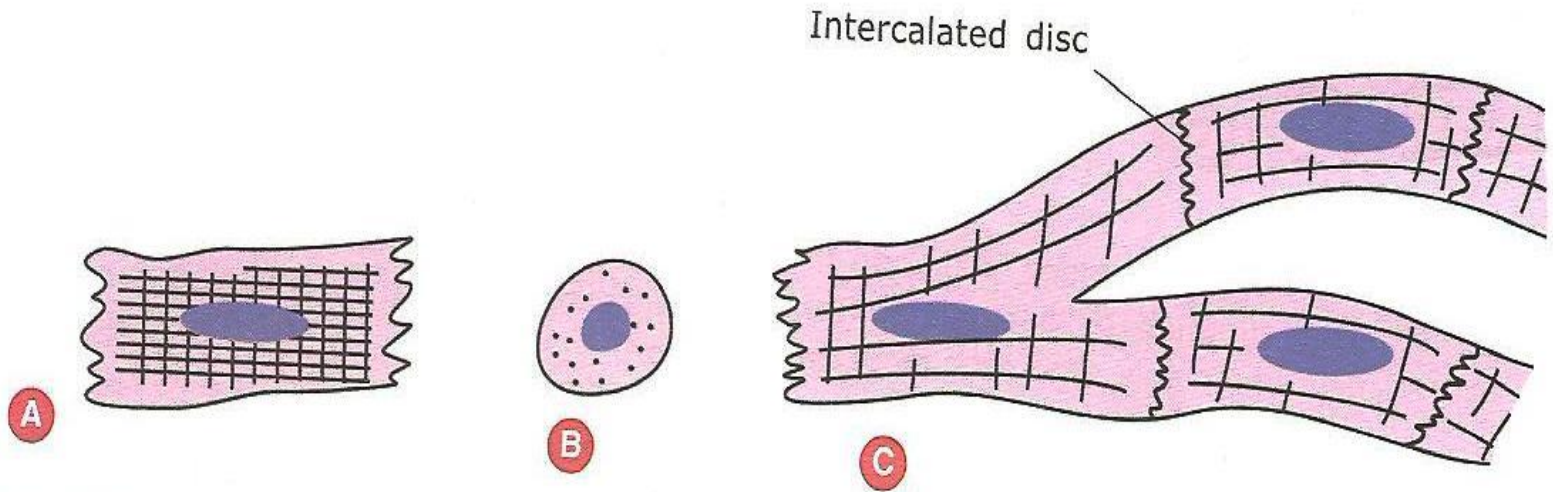
- Striated and involuntary
- Present exclusively in heart
- Originates in splanchnopleuric mesoderm
- Supplied by ANS (sympathetic & parasympathetic)

# Microscopic structure of Cardiac Muscle

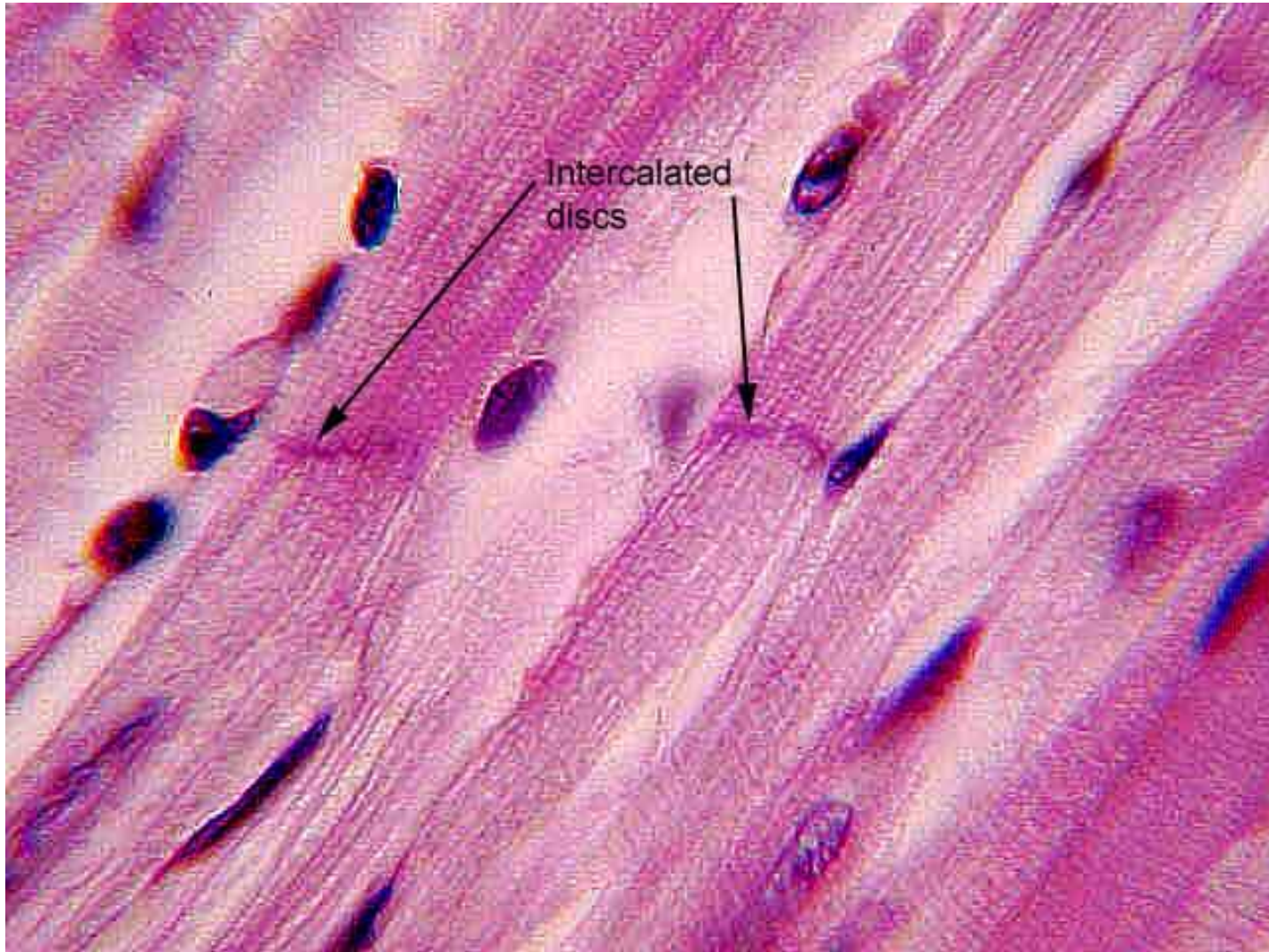
- Consists of long and thick branching muscle fibres (may appear as Y shaped)
- **Intercalated discs**
- Centrally placed single oval nucleus
- Faint transverse striations
- A & I bands along with Z discs present



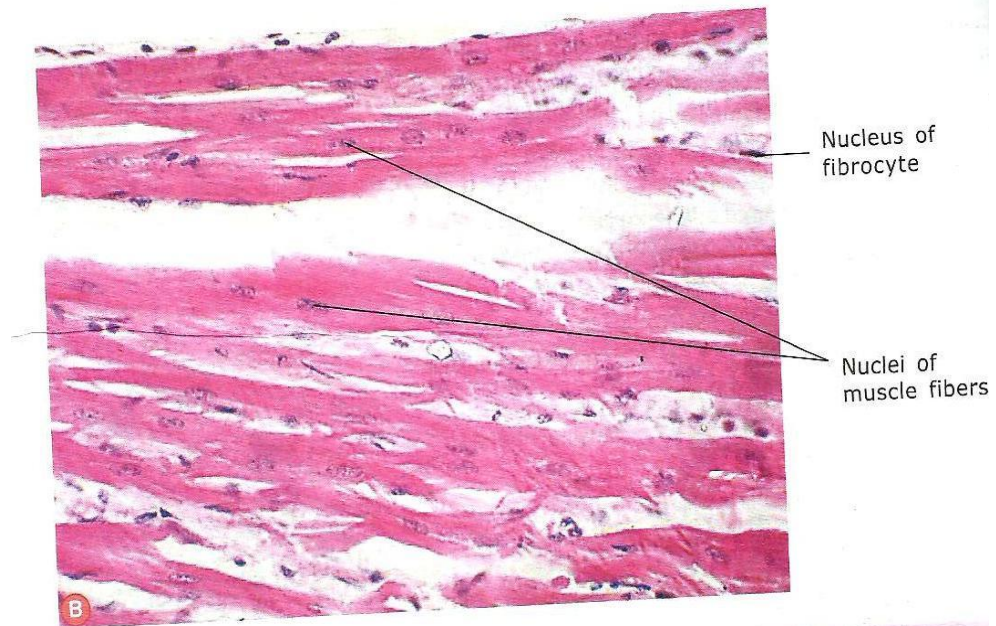
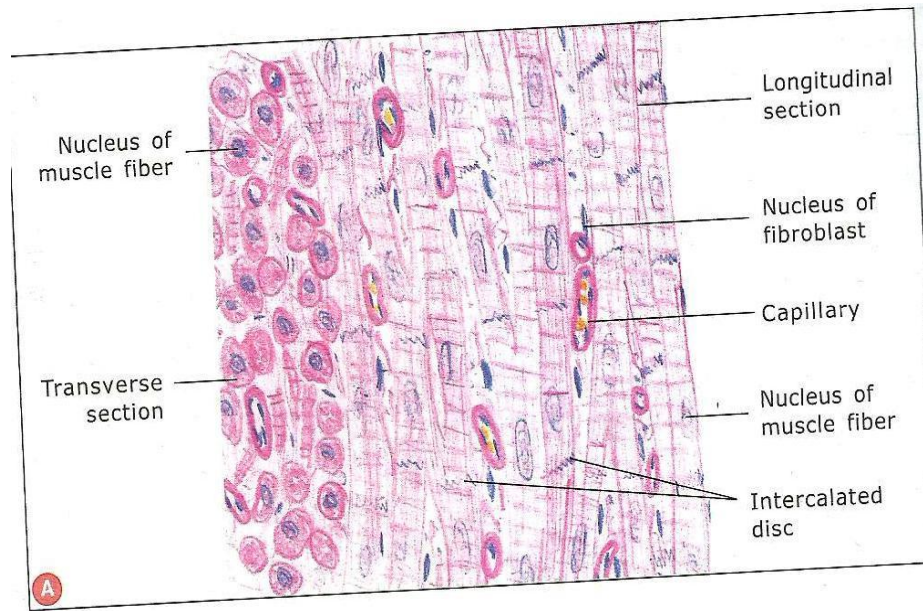
# Section of Cardiac muscle



# Cardiac Muscle







# Clinical Application

Hypertrophy can occur in cases of increased blood pressure

# Smooth Muscle

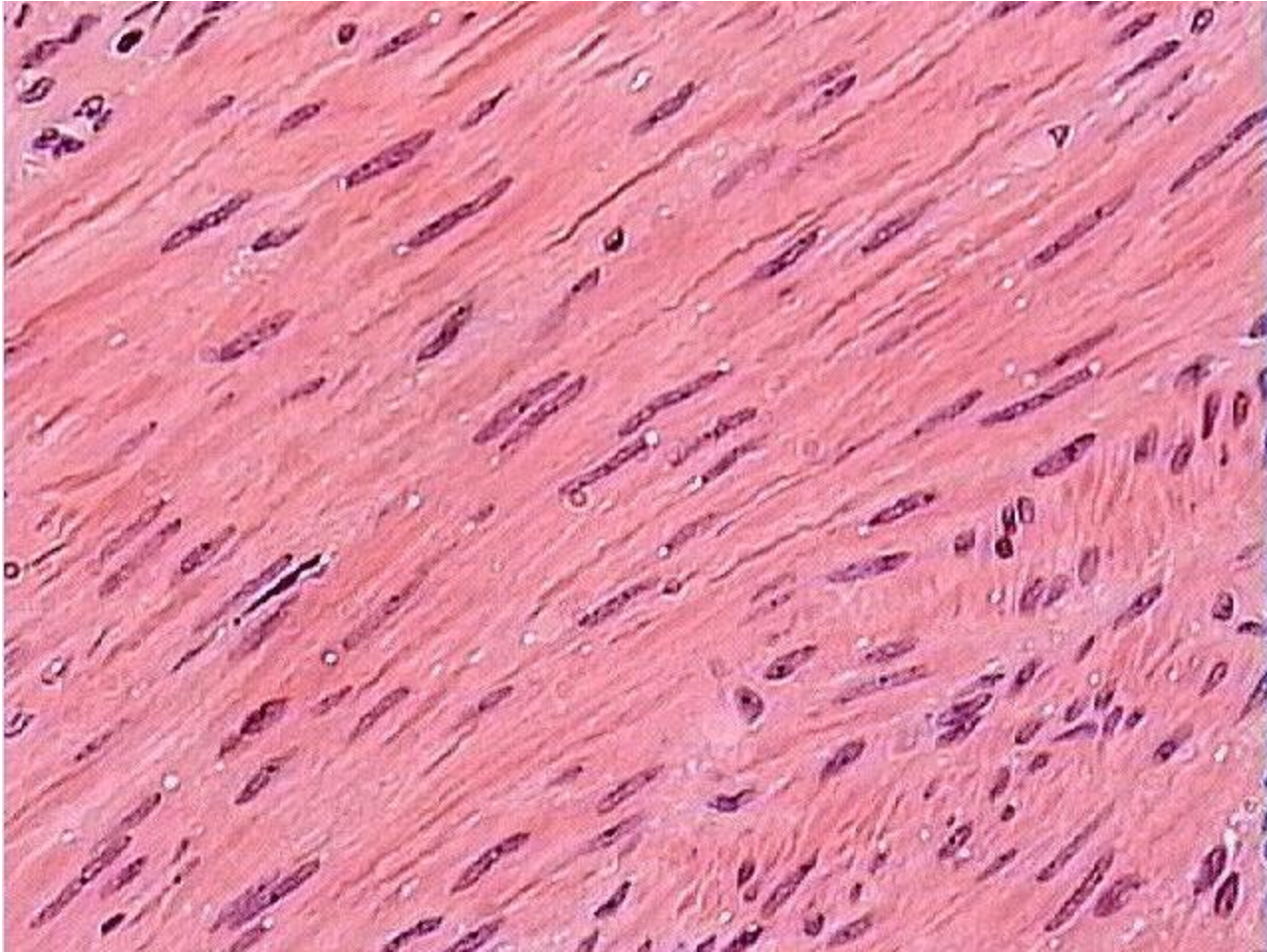
- Non-striated
- Supplied by ANS
- Present in GIT, walls of blood vessels, urinary bladder, ureter, uterus, uterine tube, arrector pili muscle (of hair follicles) etc.

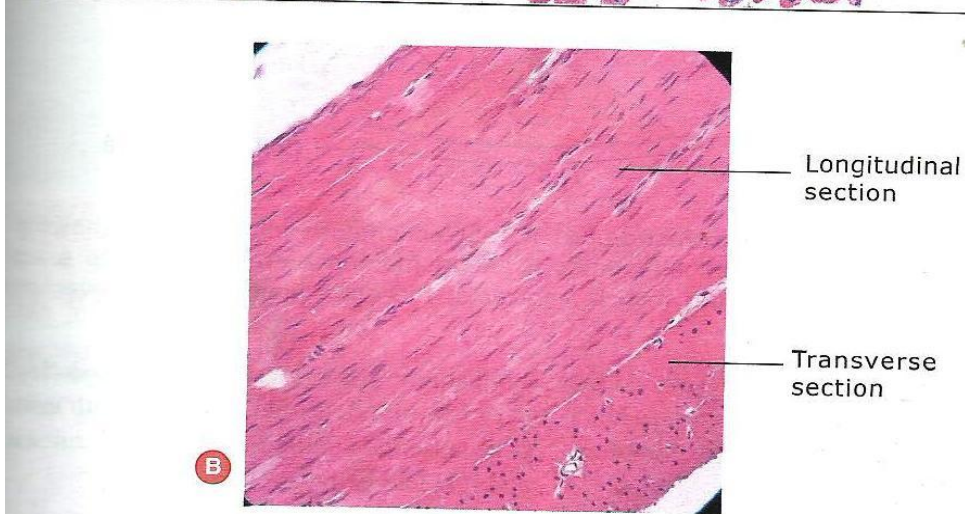
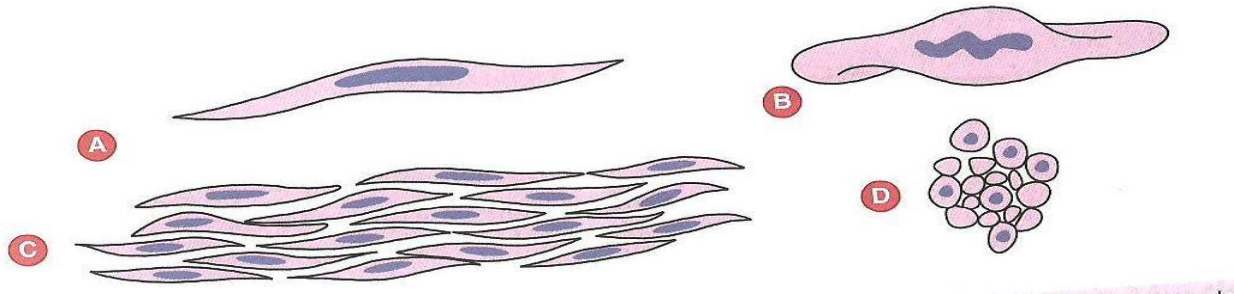
# Microscopic structure of Smooth Muscle

- Elongated spindle shaped fibres
- Centrally placed single elongated nucleus
- Adjacent cells are in contact with each other through gap junctions
- Absence of striations



# Smooth Muscle





# Clinical Application

Regeneration capacity present

(applied in restenosis of vessel following  
coronary angioplasty)



<b>Characteristic</b>	<b>Skeletal muscle</b>	<b>Cardiac muscle</b>	<b>Smooth muscle</b>
<b>1. Location</b>	Usually attached to the bones of the skeleton	Present exclusively in heart	Walls of hollow viscera, trachea, bronchi, iris and ciliary body of eye, blood vessels, arrector pili muscle of hair follicle
<b>2. Fiber</b>			
Shape	Unbranched cylindrical	Branched cylindrical	Spindle shaped
Length	Very long (100 $\mu\text{m}$ to 30 cm)	Each cardiac myocyte is 50 to 100 $\mu\text{m}$ in length	15 to 200 $\mu\text{m}$ in length (500 $\mu\text{m}$ in uterus)
Diameter	Very large (0.1 $\mu\text{m}$ )	0.14 $\mu\text{m}$	3 to 10 $\mu\text{m}$
Nucleus	Multinucleated, placed at periphery beneath sarcolemma	Single nucleus in each myocyte placed centrally	Single nucleus placed centrally
Striations	Prominent transverse striations (light and dark band)	Faint transverse striations seen	Striations not seen
<b>3. Connective tissue</b>	The connective tissue is organised in the form of endomysium, perimysium and epimysium	Organized in the form of endomysium only	Organized in the form of endomysium only
<b>4. Junctions between fibers</b>	No junctional complex present between adjacent muscle fibers	Intercalated disc contains fascia adherens, desmosomes and gap junction	Gap junctions are present in single unit (visceral) smooth muscle
<b>5. Nervous control</b>	Innervated by somatic nervous system	Innervated by autonomic nervous system	Innervated by autonomic nervous system
<b>6. Autorhythmicity</b>	No	Yes	Present only in smooth muscle of viscera
<b>7. Regeneration</b>	By the proliferation of satellite cells	No	By the mitotic division of persisting cells

# References

1. diFiore's Atlas of Histology with functional Correlations, 12<sup>th</sup> Edition.
2. Essentials of Anatomy for Dentistry Students. DR Singh, 1<sup>st</sup> Edition.
3. Textbook of Histology. GP Pal, 3<sup>rd</sup> Edition.

# MCQ

- Unbranched cylindrical shaped fiber is a feature of:
  1. Smooth muscle
  2. Skeletal muscle
  3. Cardiac muscle
  4. None of the above



# MCQ

- All of the following are microscopic features of cardiac muscle **except**:
  1. Intercalated discs
  2. Prominent transverse striations
  3. Branched cylindrical fibres
  4. Single nucleus in each myocyte

# MCQ

- Sarcomere is an area between:
  1. Two adjacent Z lines
  2. Two adjacent H bands
  3. Two adjacent M lines
  4. Two adjacent I bands

# MCQ

- All of the following are microscopic features of smooth muscle **except**:
  1. Spindle shaped fibres
  2. Single nucleus placed centrally
  3. Prominent transverse striations
  4. Gap junctions

# MCQ

- Property of regeneration is **not** seen in:
  1. Smooth muscle
  2. Skeletal muscle
  3. Cardiac muscle
  4. All of the above