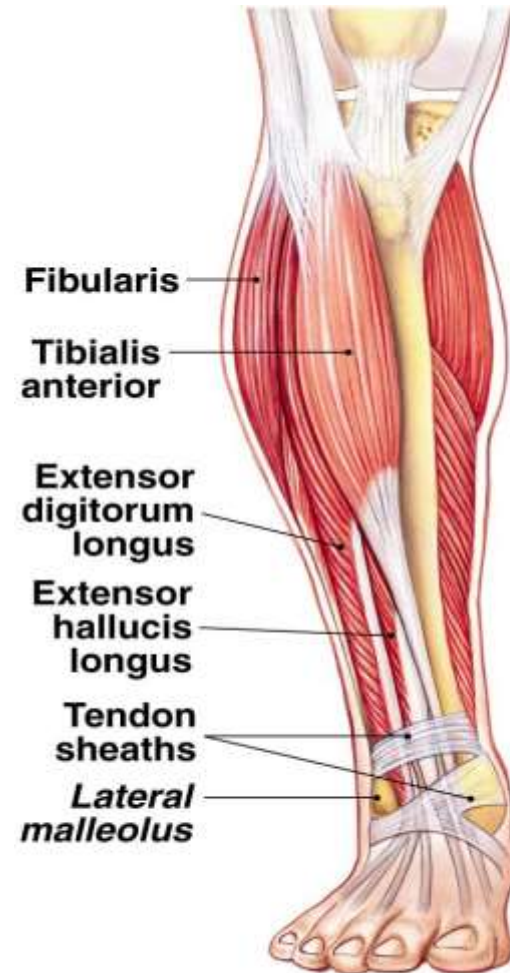


# ANATOMY OF MUSCLE



# DERIVATION OF NAME

- Muscle (**Latin Mus= mouse**) are so named because many of them resemble a mouse, with their tendons representing the tail.



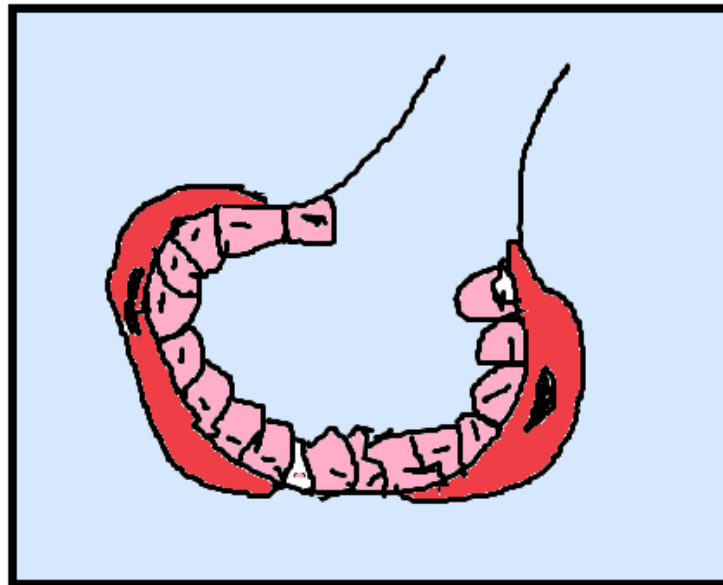
(c) Anterior view, right leg

# DEFINITION

- **Muscle is a contractile tissue which brings about movements.**
- **Muscles can be regarded as motors of the body.**

## Other contractile cells:

- **Myofibroblasts**- seen in regenerating connective tissue.
- **Myoepitheliocytes**- associated with glands.



# ***BASIC PROPERTIES***

- **IRRITABILITY:**

- Sensitive to stimuli

- **CONTRACTILITY:**

- When stimulated, the contracts lengthwise leading to its shortening

- **EXTENSIBILITY:**

- Once stimuli removed, the muscle fibers return to their original length.

- **ELASTICITY:**

- Muscle assumes a desired shape.

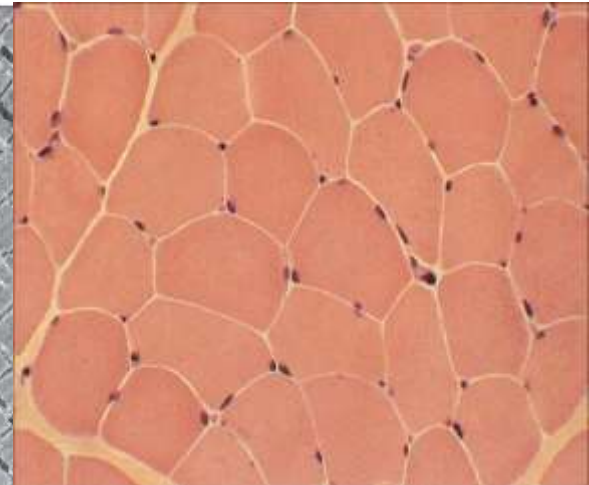
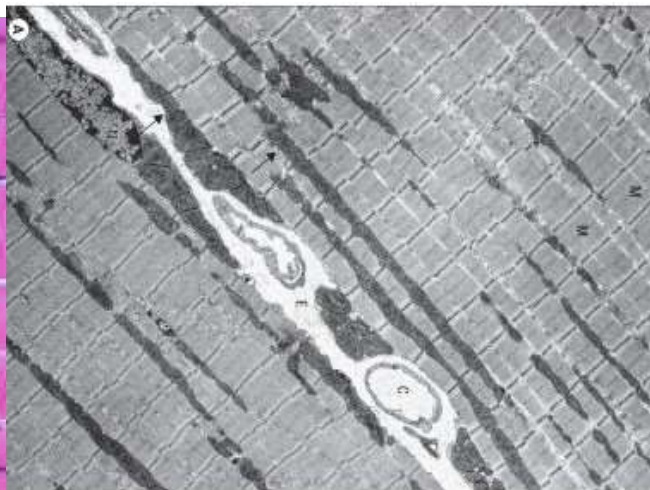
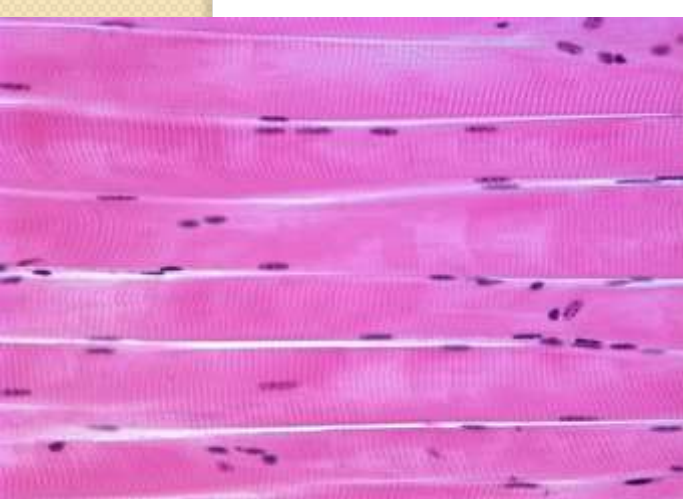
# **Types of muscles**

**There are three types of muscles :**

- **1. Skeletal muscles**
- **2. Smooth muscles**
- **3. Cardiac muscles**

## ***Skeletal muscle tissue***

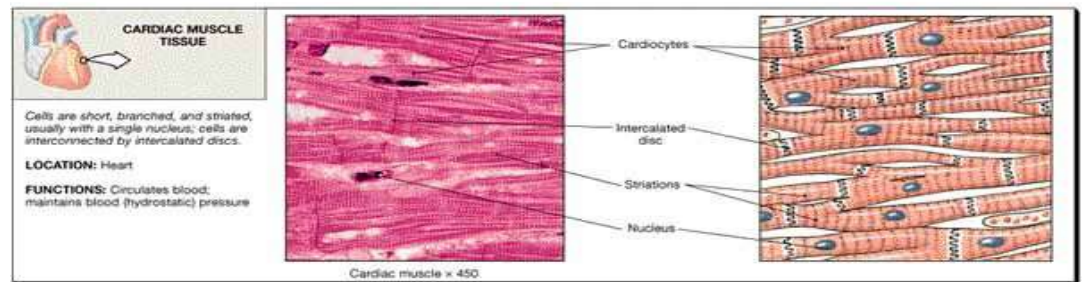
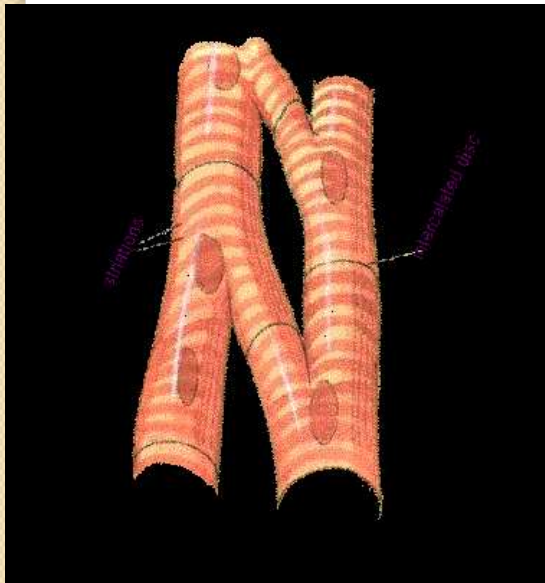
- **Attached to skeleton**
- **Cross-striated**
- **Voluntarily controlled**
- **Cells are cylindrical and multinucleated**
- **They respond quickly but fatigue easily**





# Cardiac muscle tissue

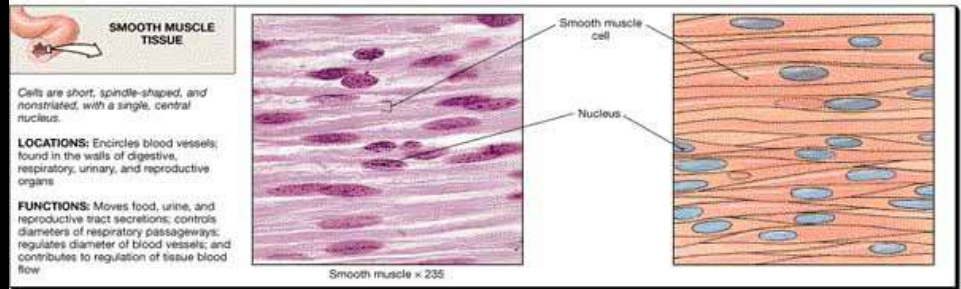
- Makes up myocardium of heart
- Unconsciously (*involuntarily*) controlled
- Microscopically appears *striated*
- Cells are short, branching & have a single nucleus
- Cells connect to each other at *intercalated discs*





# *Smooth (visceral) muscle tissue*

- Makes up walls of organs & blood vessels
- Tissue is *non-striated* & *involuntary*
- Cells are short, spindle-shaped & have a single nucleus
- Tissue is extremely extensible, while still retaining ability to contract



# *Skeletal muscles*

## **Synonyms**

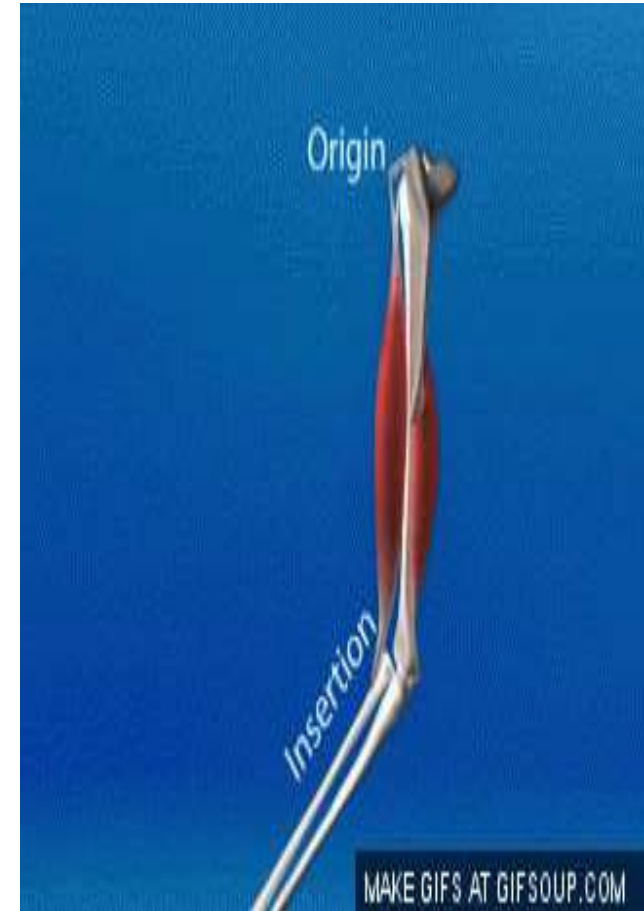
- 1. Striped muscles**
- 2. Striated muscles**
- 3. Somatic muscles**
- 4. Voluntary muscles**



# PARTS OF A SKELETAL MUSCLE

A. Two ends

1. **Origin** is one end of the muscle which remains **fixed** during its contraction
2. **Insertion** is the other end which **moves** during its contraction. In the limb muscles, origin is usually proximal to insertion.

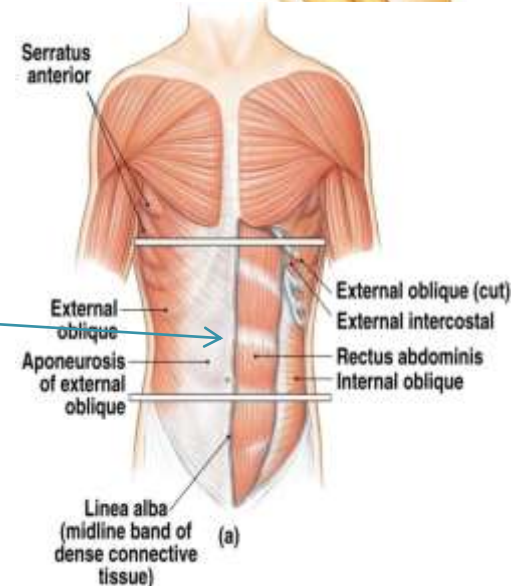
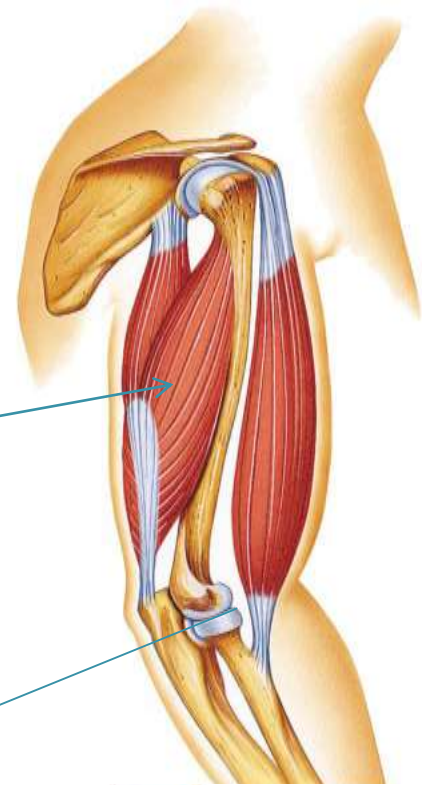


## B. Two parts

1. **Fleshy part is contractile**,  
and is called the '**belly**'.

2. **Fibrous part is noncontractile**  
and is elastic. When cord-like or  
rope-like, it is called '**tendon**';  
when flattened it is called

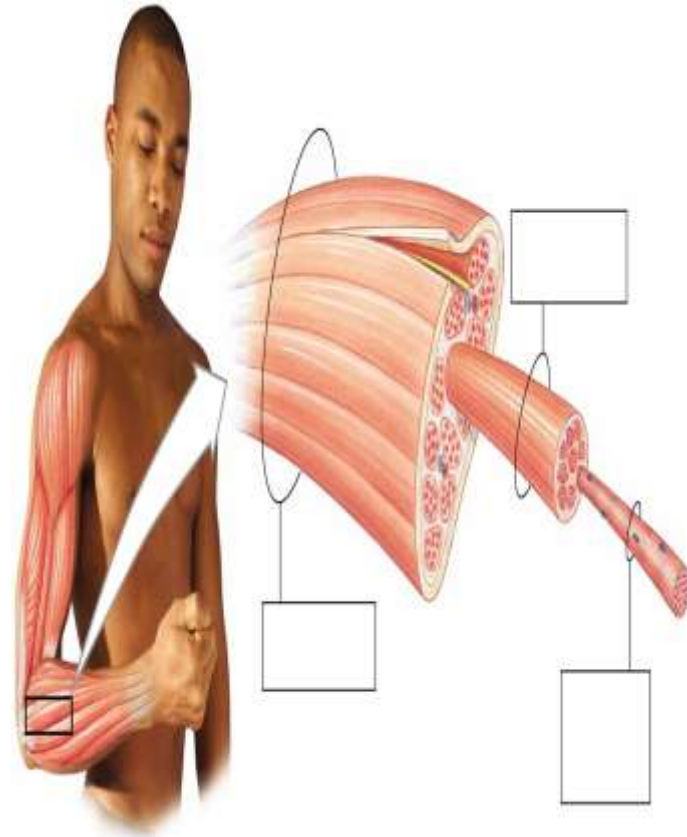
'**aponeurosis**'.



# Structure of striated muscle

## A. CONTRACTILE TISSUE

- Each muscle is composed of numerous muscle fascicles.
- Each muscle fascicle has numerous muscle fibres.
- Each muscle fibre is a multinucleated, crossstriated cylindrical cell (myocyte).

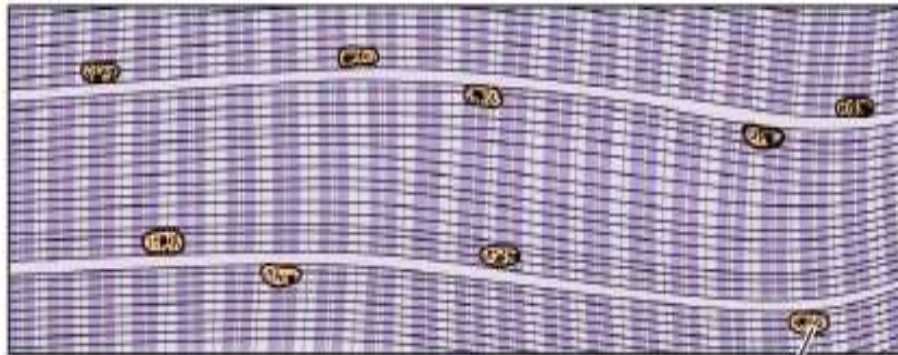




# MYOCYTE

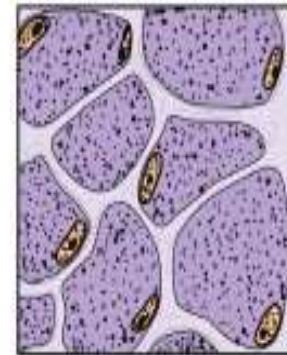
- **Sarcolemma**- membrane
- **Peripheral nuclei** – Multinucleated
- **Sarcoplasm**- cytoplasm
- **Longitudinal myofibrils**

Skeletal muscle



Nuclei

Cross sections



Strong, quick  
discontinuous  
voluntary  
contraction



# MYOFIBRIL

- Each myofibril is composed of longitudinal protein filaments, called **myofilaments**:

- Actin (thin)

- Myosin (thick)

- Each myofibril shows alternate dark and light bands

- **Dark bands :**

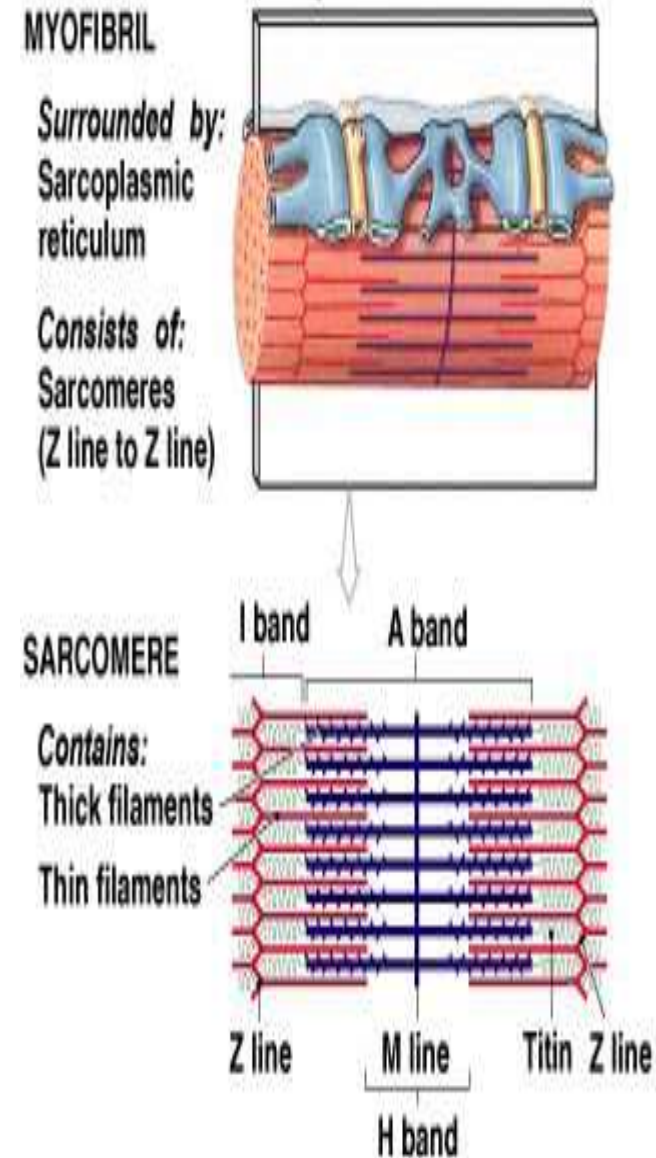
A bands (anisotropic)

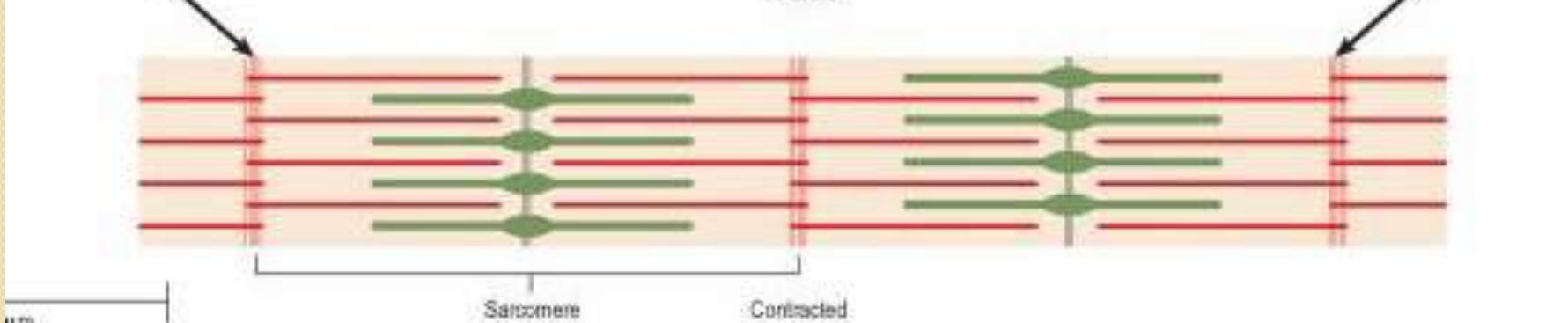
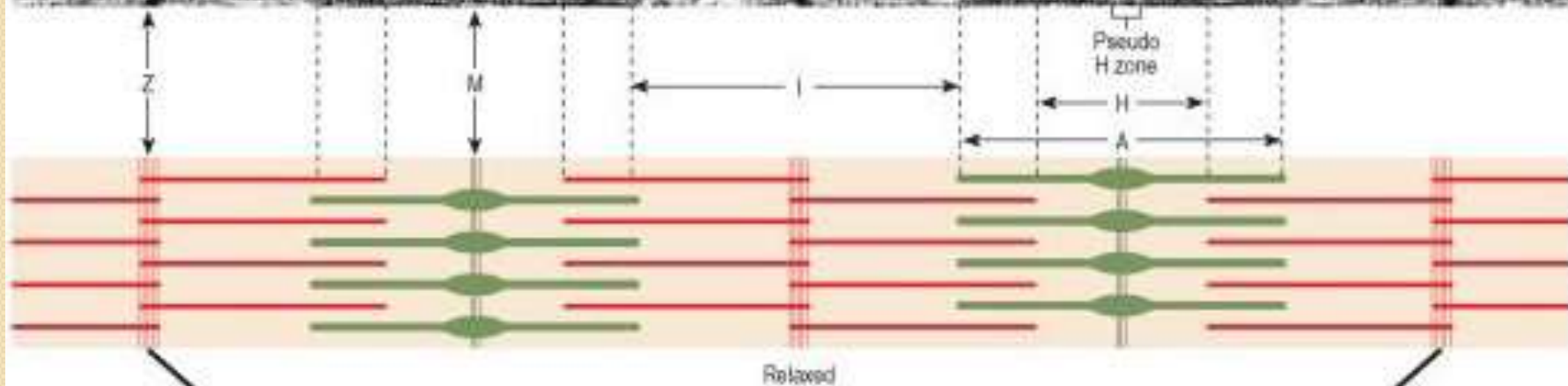
- **Light bands:**

I bands (isotropic).

- In the middle of the A band, there is a light H band with M line (dark) in the middle.

- In the middle of the I band there is a dark Z disc or **Krauses membrane**.





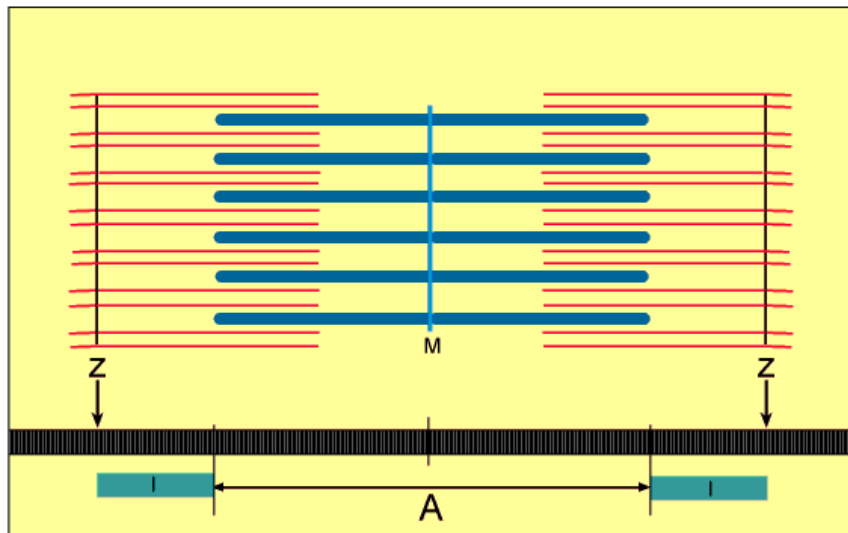
um

Sarcomere

Contracted

The segment of myofibril between two Z discs is called **sarcomere**.

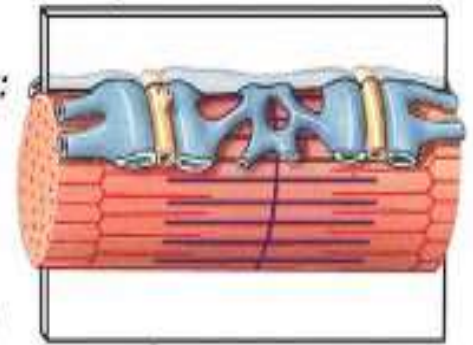
- Sarcomere is the **structural and functional unit of muscle**.



#### MYOFIBRIL

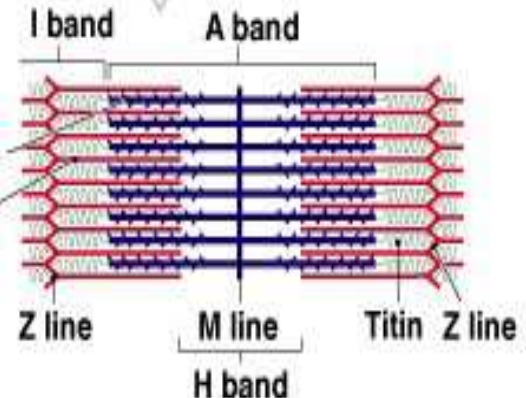
Surrounded by:  
Sarcoplasmic  
reticulum

Consists of:  
Sarcomeres  
(Z line to Z line)



#### SARCOMERE

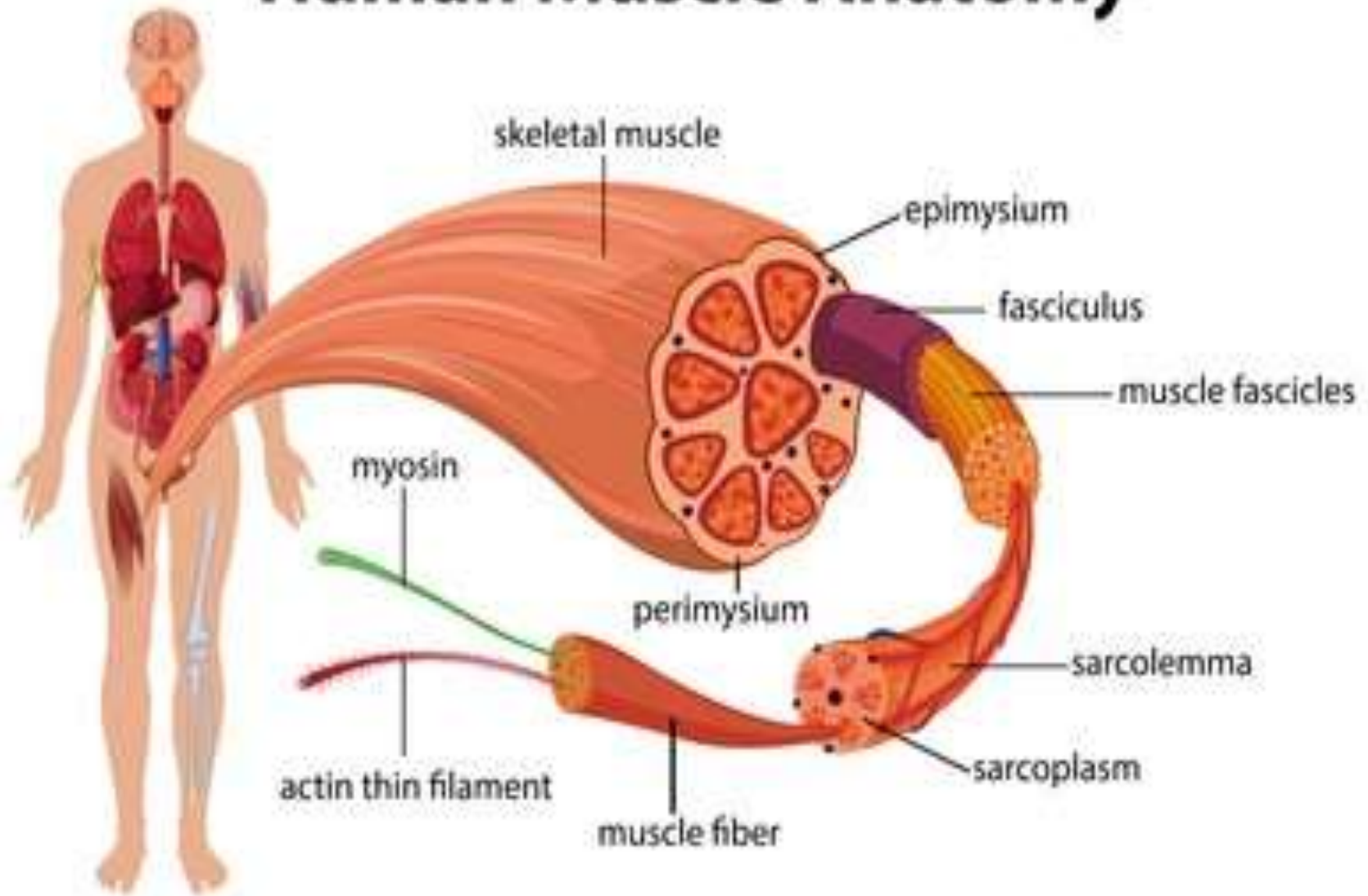
Contains:  
Thick filaments  
Thin filaments



## ***B. SUPPORTING TISSUE***

- *It helps in the organization of the muscle.*
- *Epimysium*
- *Perimysium*
- *Endomysium*
- *The connective tissue of the muscle becomes continuous with the tendon.*

# Human Muscle Anatomy





# Slow and Fast Muscle Fibres

## *1. Type I (slow,red) fibres*

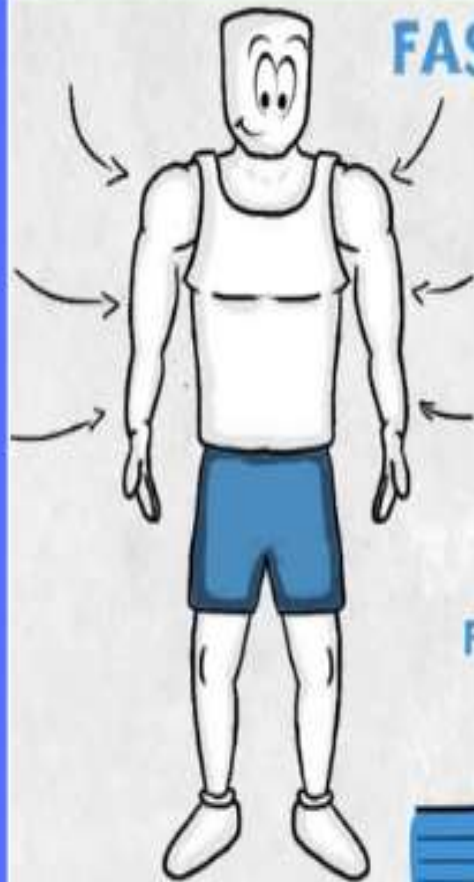
- show a slow ‘tonic’ contraction characteristic of *postural muscles*.
- They are *red in colour because of large amounts of myoglobin*.
- The fibres are *rich in mitochondria and oxidative enzymes but poor in phosphorylases*.
- Because of well developed metabolism, slow fibers are highly resistant to fatigue.



## 2. *Type II (fast, white) fibres*

- show a fast ‘phasic’ contraction required for large-scale movements of body segments (nonpostural muscles)
- These are *paler (white) in color because of* small amounts of myoglobin.
- These fibres are rich in glycogen and phosphorylases, but poor in mitochondria and oxidative enzymes.
- Because of anaerobic glycolytic respiration, the fast fibres are quite easily fatigued.

## FAST TWITCH FIBERS



Type 2a or 2b  
Anaerobic  
Pale in Colour  
Low blood supply  
Fatigue rapidly  
Low number of capillaries  
Low number of mitochondria

SPRINTER

FAST TWITCH FIBERS



## SLOW TWITCH FIBERS



Type 1  
Aerobic  
Red in Colour  
High blood supply  
Fatigue slowly  
High number of capillaries  
High number of mitochondria

MARATHONER

SLOW TWITCH FIBERS



Why Can't I understand key muscle fibre types?

# **FUNCTIONS**

- **MOTION:**

- E.g. Walking, running

- **HEAT PRODUCTION:**

- Metabolism within muscle cell release heat as end product.

- Rate of heat production increases when person performs strenuous exercise.

- **POSTURE AND BODY SUPPORT:**

# FASCICULAR ARCHITECTURE OF MUSCLES

- The arrangement of muscle fibres varies according to
  - direction,
  - force
  - range of movement at joint.



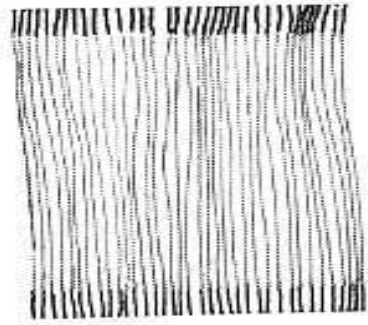
# **CLASSIFICATION OF MUSCLE ACCORDING TO THE ARRANGEMENT OF THE FASCICULI**

**A.Parallel Fasciculi**

**B.Oblique Fasciculi**

**C. Pennate Fasciculi**

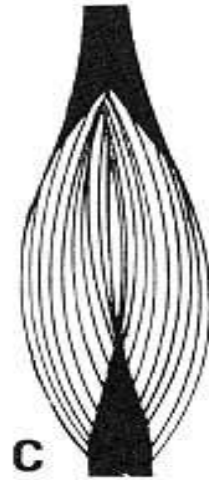
**D.Spiral or Twisted Fasciculi**



**A**



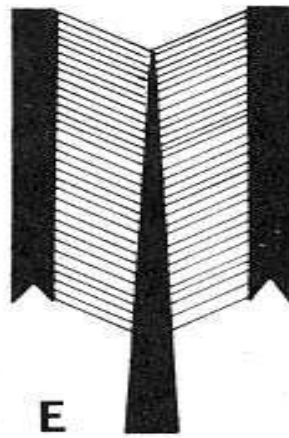
**B**



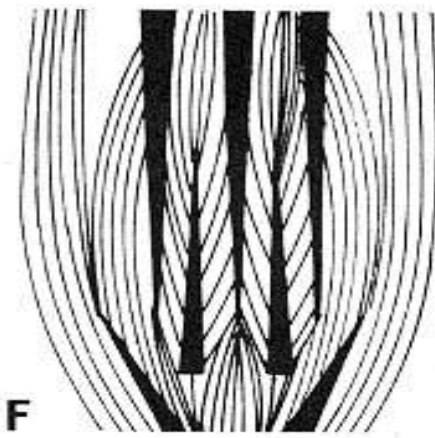
**C**



**D**



**E**



**F**

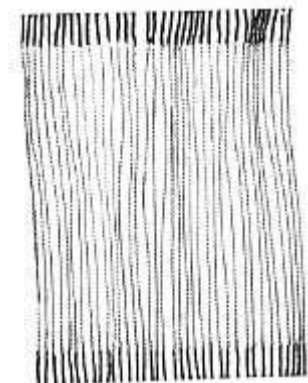
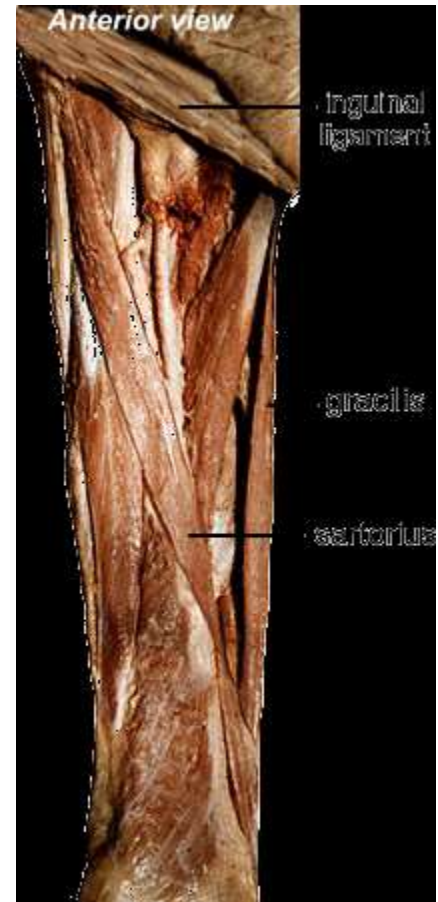


## ***A. Parallel Fasciculi***

When the fasciculi are parallel to the line of pull, the muscle may be:

(1) **quadrilateral** e.g. thyrohyoid

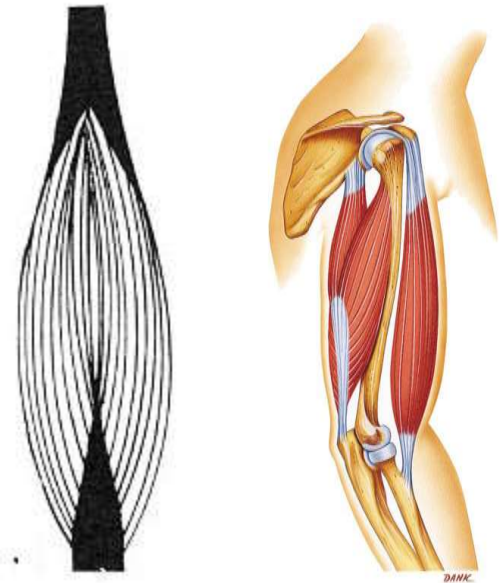
(2) **straplike** e.g. sternohyoid, sartorius



**(3) strap-like with tendinous  
Intersections e.g. rectus abdominis**



**(4) fusiform e.g. biceps, digastric**  
**The range of movement in  
such muscle is maximum**



## ***B. Oblique Fasciculi***

### **1. Triangulare.**

e.g. adductor

Longus

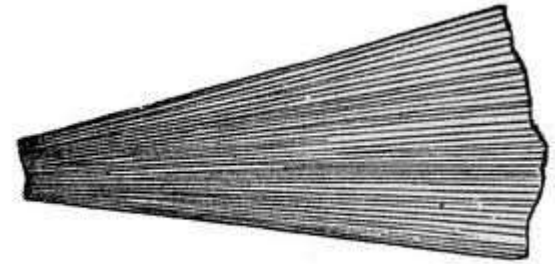
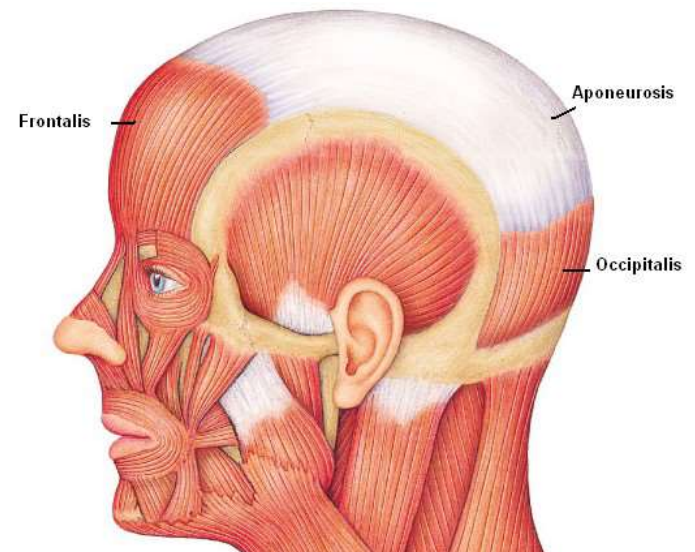


FIG. 21

### **2. Fan shaped**

e.g. temporalis



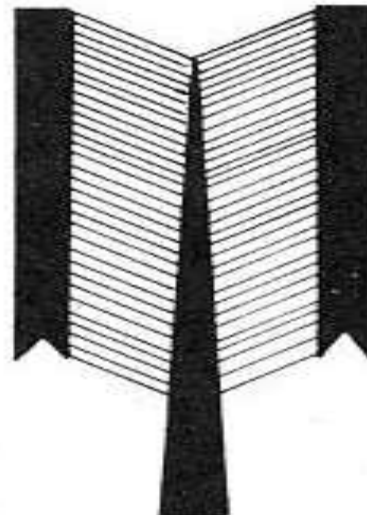
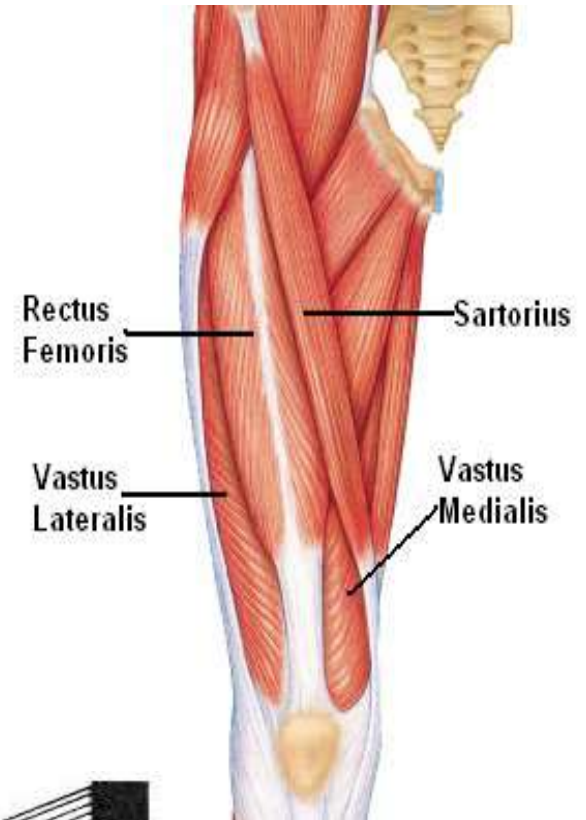
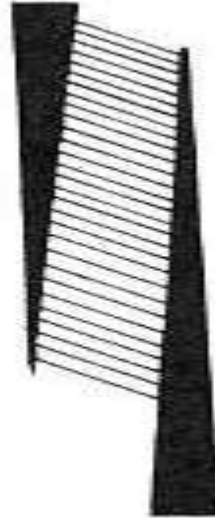
## **C. Pennate Fasciculi**

### **1. Unipennatee.**

**e.g. flexor pollicis longus, extensor digitorum longus, peroneus tertius**

### **2. Bipennatee.**

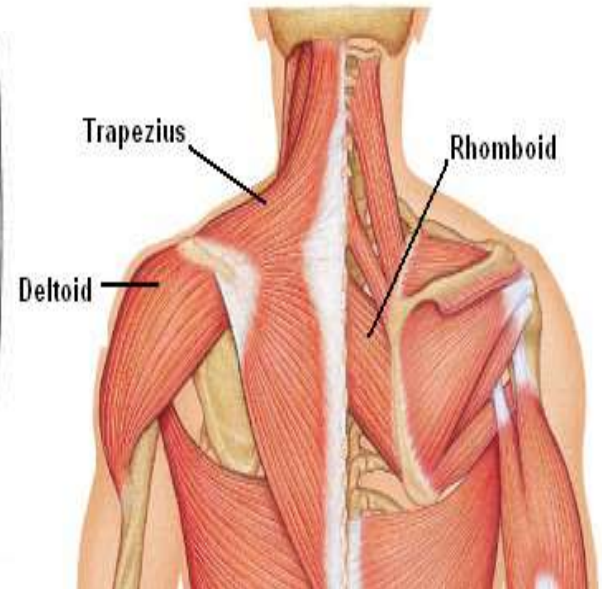
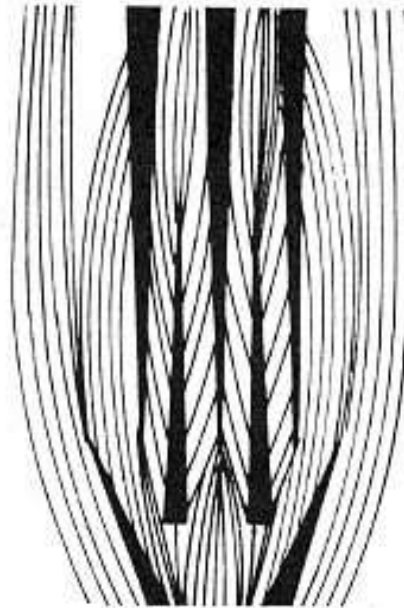
**e.g. rectus femoris, dorsal interossei, peroneus longus, flexor hallucis longus**





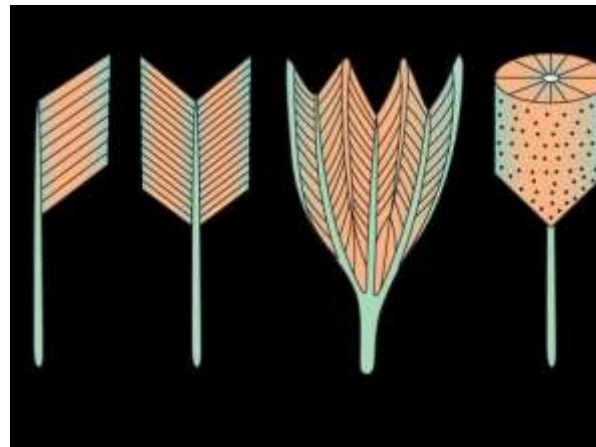
### 3. **Multipennatee.**

**Eg. deltoid,  
Subscapularis**



### 4. **Circumpennatee.**

**Eg. tibialis  
anterior**

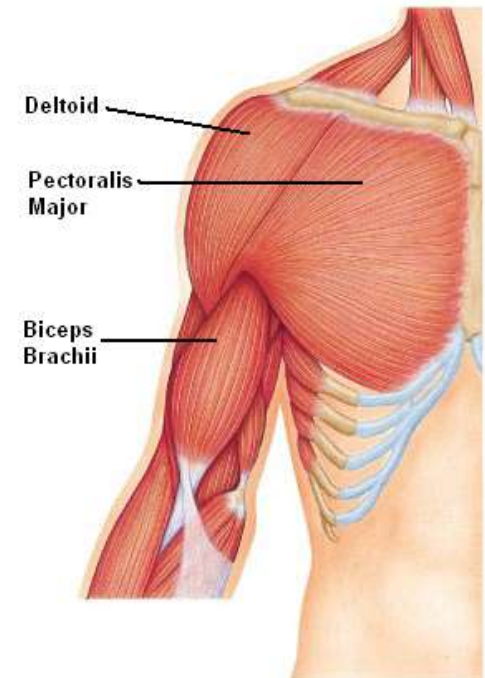
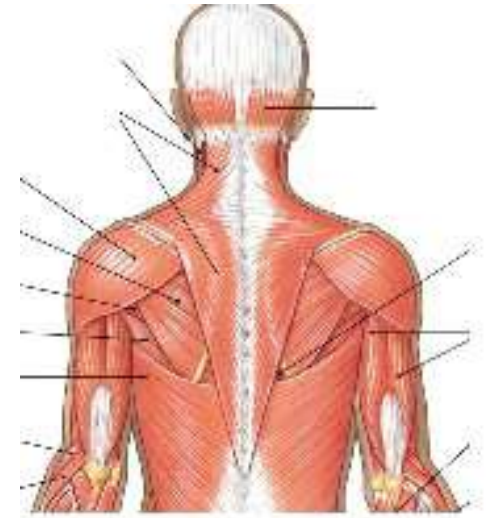


(c) Anterior view, right leg

## ***D. Twisted Fasciculi***

### **1. Spiral fibres:**

**found in trapezius, latissimus dorsi, pectoralis major, supinator etc.**

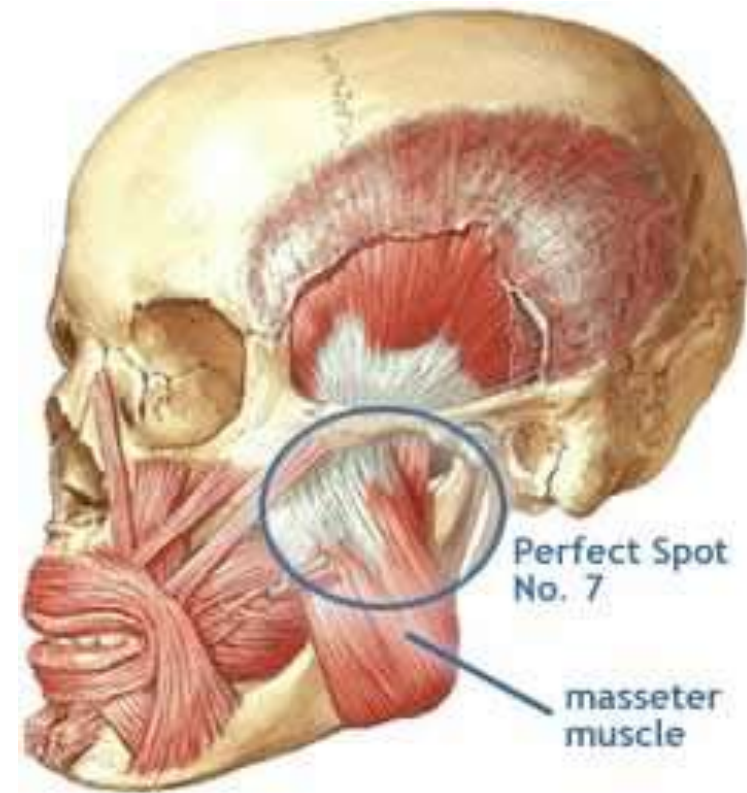




## 2. Cruciate fibres:

**In certain muscles  
the fasciculi are  
crossed.**

**e.g. sternocleidomastoid,  
masseter, adductor  
magnus.**



# NOMENCLATURE OF MUSCLES

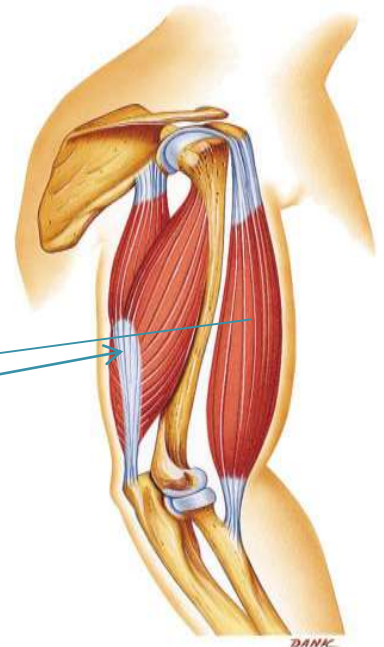
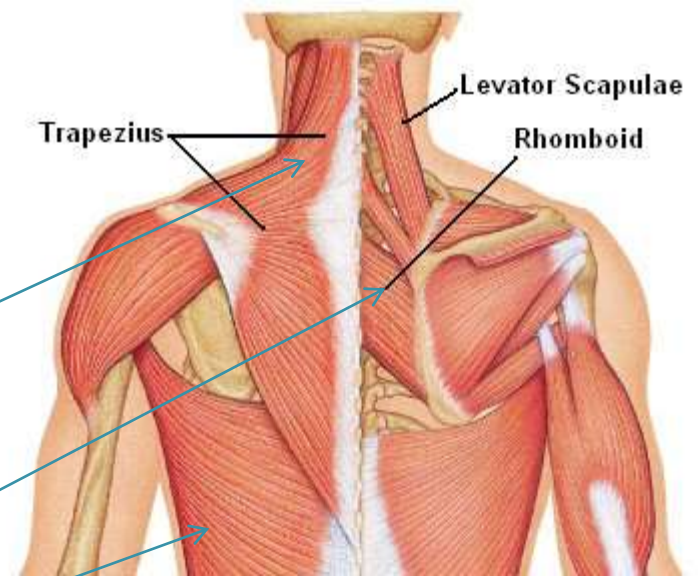
The muscles have been named in a number of ways

## SHAPE

e.g. trapezius, rhomboideus, serratus anterior, latissimus dorsi, etc.

## NUMBER OF HEADS OF ORIGIN

e.g., biceps, triceps, quadriceps, digastric, etc.

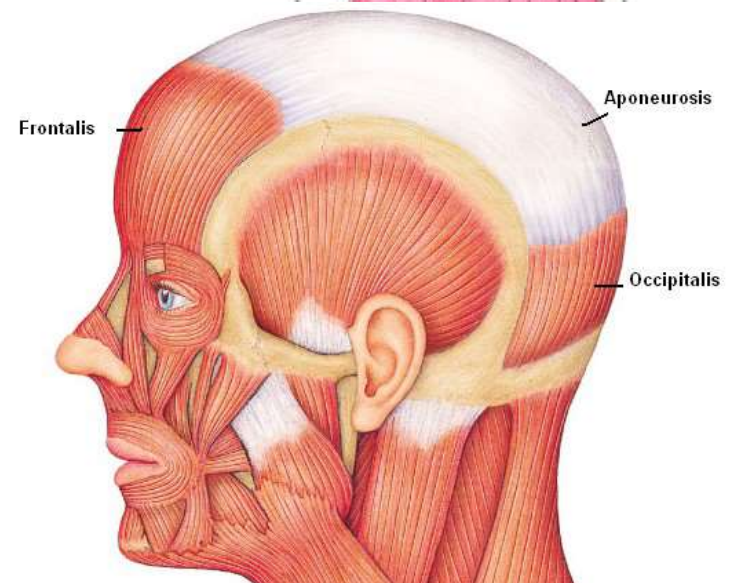
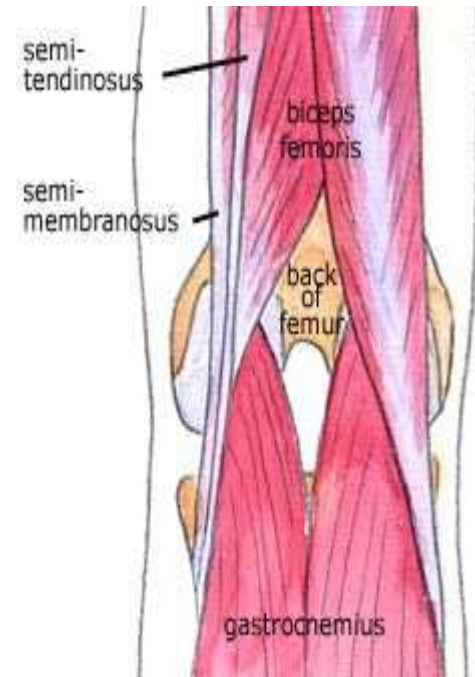


## **GROSS STRUCTURE**

**e.g., semitendinosus,  
semimembranous, etc.**

## **LOCATION**

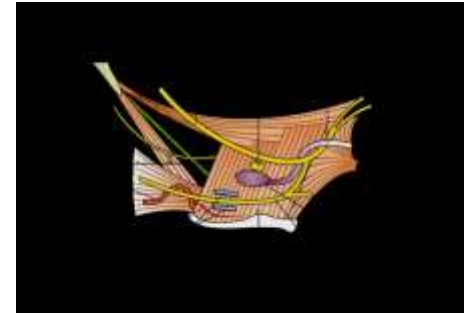
**e.g temporalis,  
supraspinatus,  
intercostals, etc.**



**ATTACHMENTS** e.g.,  
stylohyoid, cricothyroid, etc.

**FUNCTION** e.g., adductor  
longus, flexor carpi ulnaris,  
abductor pollicis longus,  
etc.

**DIRECTION OF FIBRES**  
e.g., rectus abdominis,  
oblique abdominis,  
transversus, etc.



# Blood supply of skeletal muscle

- Blood supply is derived from muscular branches from **neighbouring arteries**.
- The arteries, veins and motor nerve pierce the muscle at a fairly constant point called **neurovascular hilum**.
- The arteries divide repeatedly to form **arterioles in the perimysium**, and **capillaries in the endomysium** for nutritive circulation.



# **Nerve supply of skeletal muscle**

**The nerve supplying a muscle is called a motor nerve. In fact it is a mixed nerve.**

- **1. MOTOR FIBRES (60%)**
- **2. SENSORY FIBRES (40%)**



# NEUROMUSCULAR JUNCTIONS:

- On approaching the muscle the axons of motor nerve **lose their myelin sheath** and break up into a number of branches to supply the individual **muscle fibres**.
- These specialized motor nerve endings, rich in **acetylcholine** form junction with the muscle fibre called **Neuromuscular junction**.

## **Nerve part:**

**Motor end plate**

**Pre synaptic membrane**

**Synaptic vesicle**

## **Muscle part:**

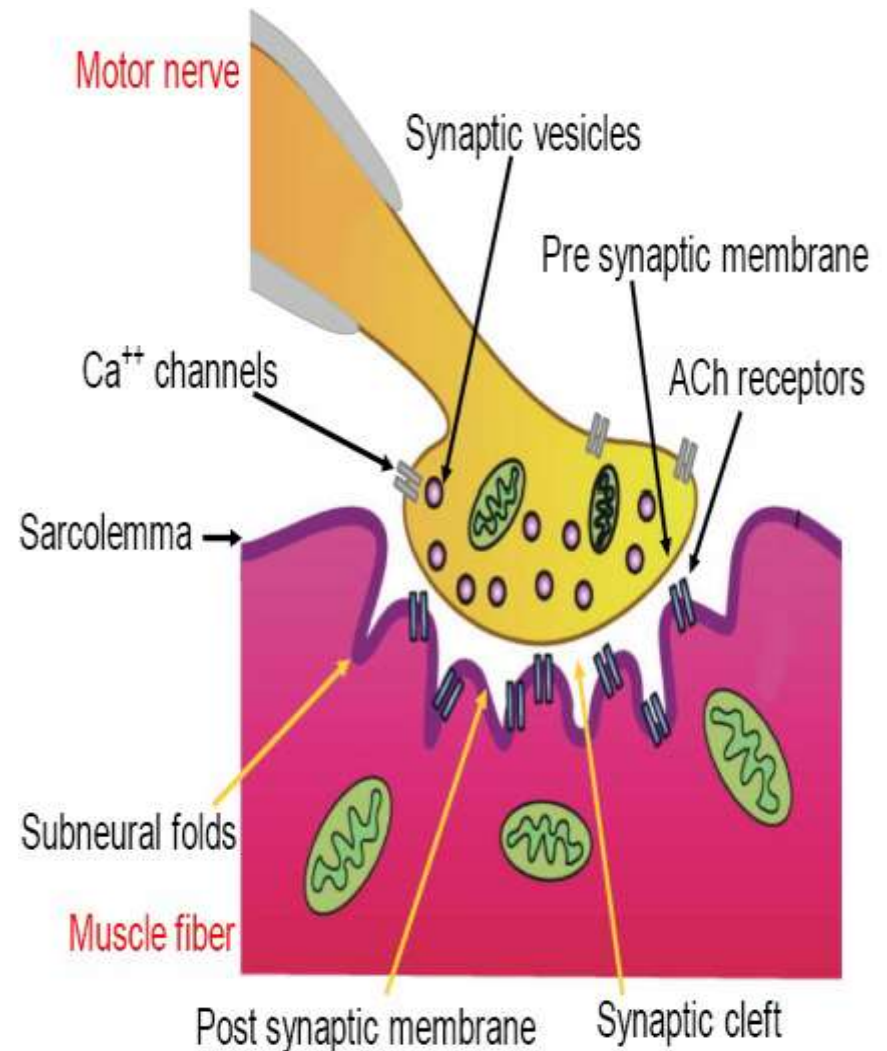
**Sole plate**

**Synaptic Cleft**

**Granular sarcoplasm**

**Nuclei & mitochondria**

**Subneural clefts**



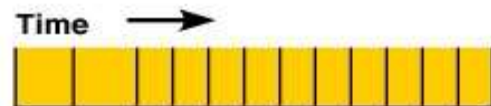
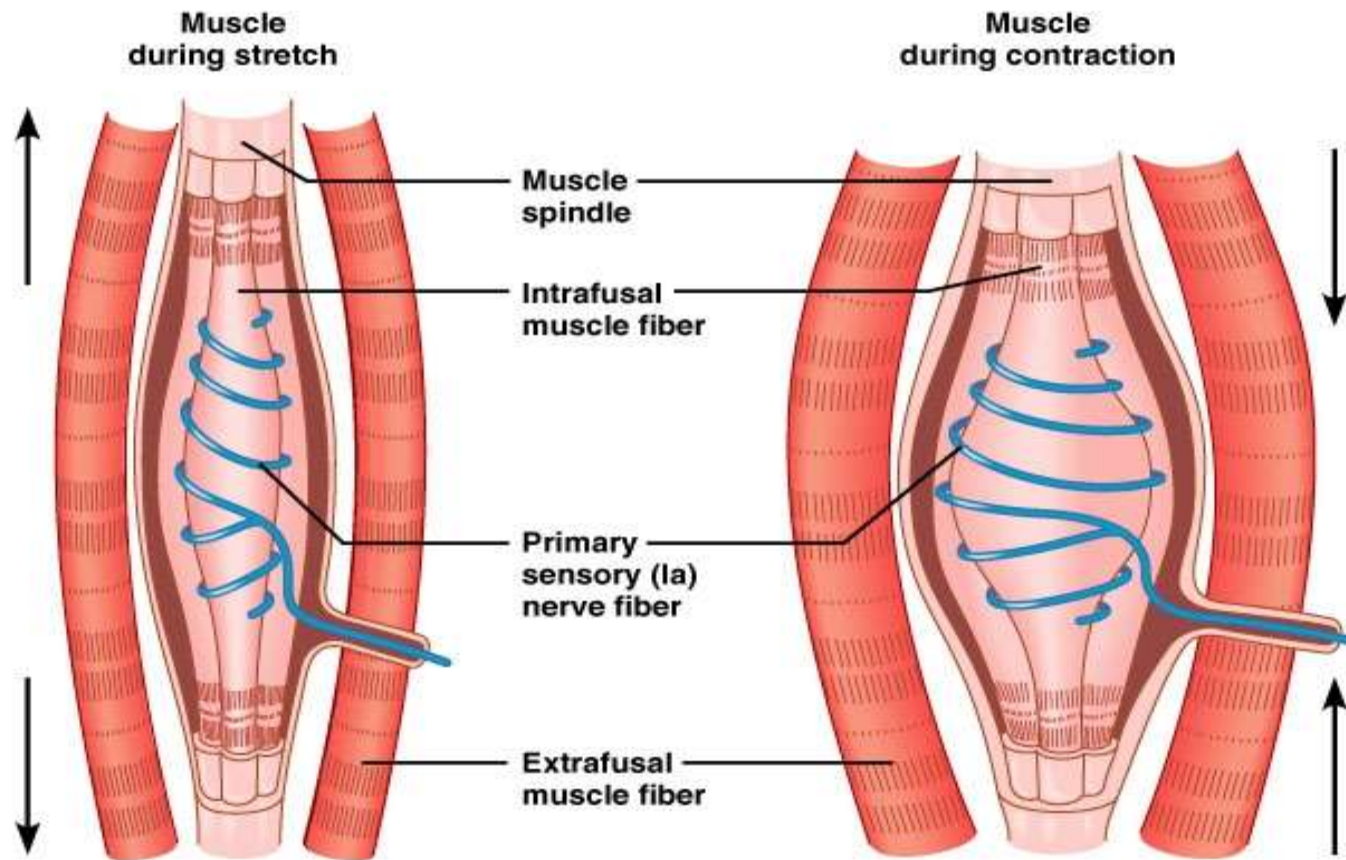
# Neuromuscular Spindle

- **Definition:**

- Spindle shaped sensory end organs within skeletal muscle provide sensory information to CNS to control tone of muscle.

- Each spindle:

- Intrafusal fibers
- Extrafusal fibers



**(a) Action potential frequency increases during stretch**



**(b) Action potential frequency declines during contraction**

# ACTION OF MUSCLES

- **Muscle Tone:** The constant tension produced by muscles for long period of time.
- **Type of muscle contraction:**
- **Isometric contraction**
  - length of muscles do not change but tension does increases..
- **Isotonic contraction**
  - Tension produced by muscle is constant during contraction but **length of muscle changes.**

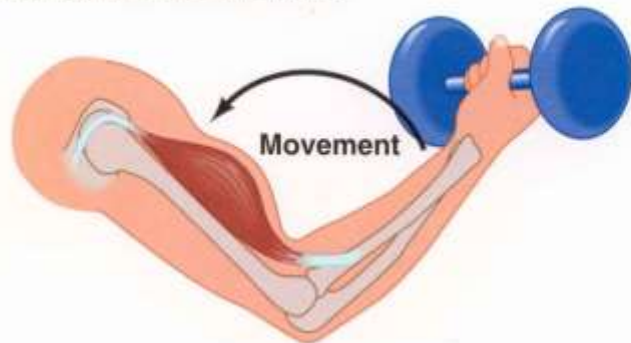
### Isometric contraction

Muscle contracts  
but does not shorten



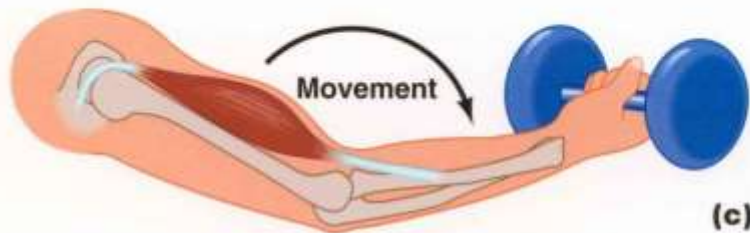
(a)

### Concentric contraction



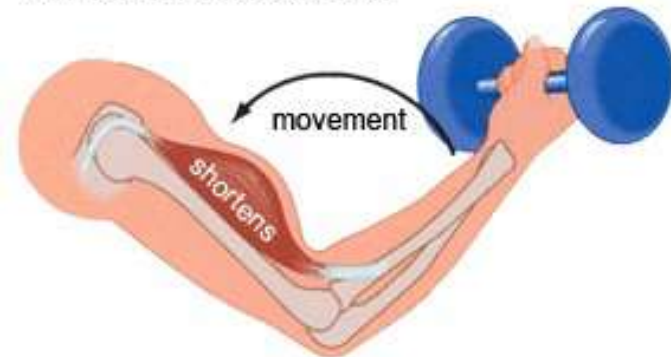
(b)

### Eccentric contraction



(c)

### concentric contraction





# GROUP ACTION OF MUSCLES

- **A. Prime movers (agonists) Bring about the**
  - desired movement.
- **B. Antagonists (opponents) Produce**
  - movement opposite to prime mover. They
  - help the prime movers by active controlled
  - relaxation.
- **C. Fixators They stabilize the origin of prime**
  - mover so it can act efficiently.
- **D. Synergists: When the prime movers cross**
  - more than one joint, the undesired actions at
  - the proximal joints are prevented by certain
  - muscles known as synergists

- 
- **THANK YOU**

# **FUN FACTS**

- The smallest muscles are found in the middle of your ear.
- Muscles make up 40% of your total body weight
- It takes half as long to gain muscle then it does to lose it
- To take one step it takes 200 muscles
- The tongue is the strongest muscle in the body