JOINTS

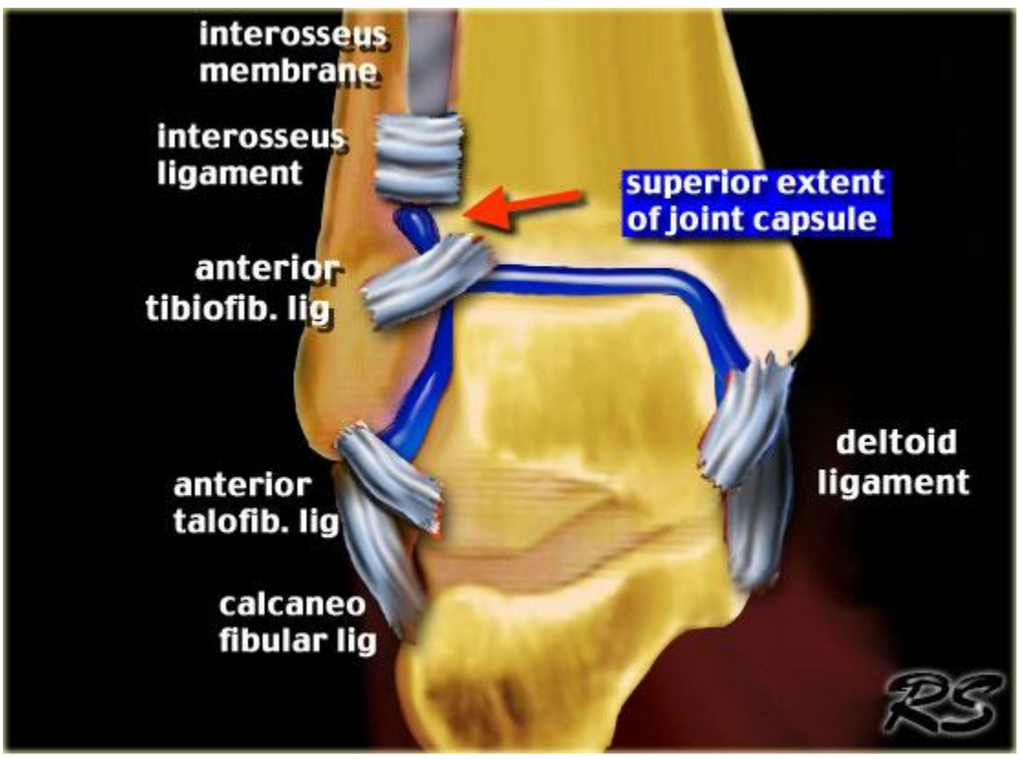
★ **Definition** : The joint is the contact (articulation) between two or more bones together.

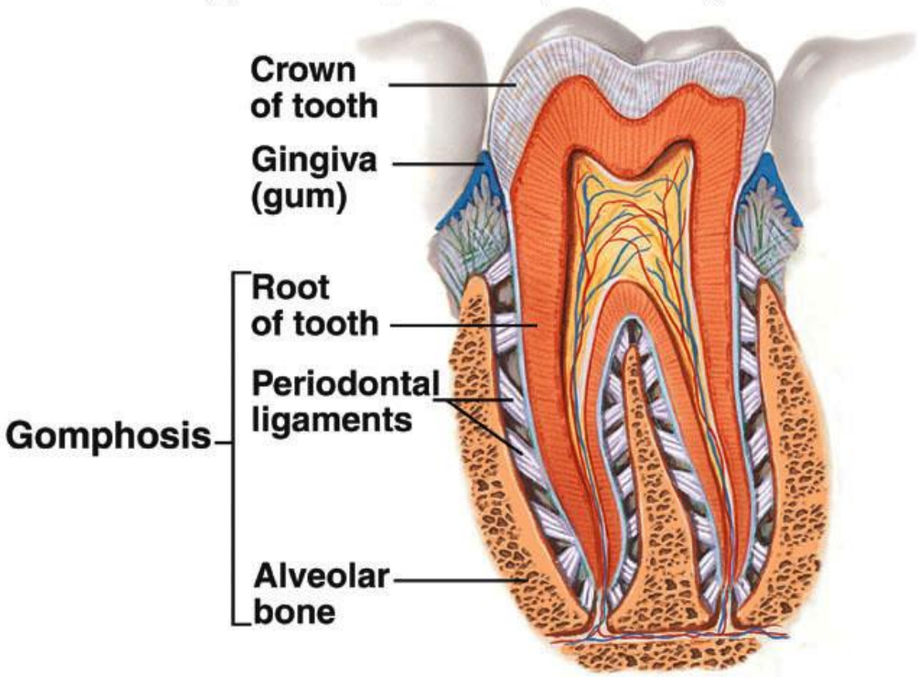
★ **Classification of Joints :** There are 3 types of joints.

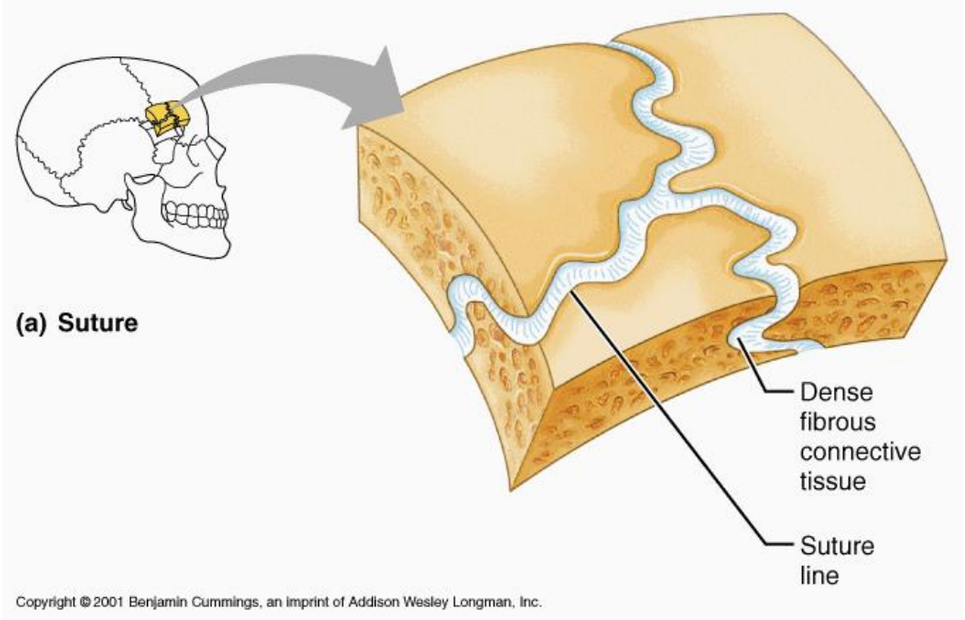
I. Fibrous Joints: (false joint)

- ***Fixed*** joints in which the surfaces of articulating bones are ***connected*** together by ***fibrous*** tissue.
- There are 3 types:

1- Syndesmosis	2- Gomphosis	3- Sutures
▪ Present in **inferior tibio fibular** joint. ▪ The lower end of tibia and fibula are connected together by fibrous tissue called **interosseous ligament**	▪ Present in **teeth**. ▪ The roots of teeth are connected to their **sockets** in the bones by fibrous tissue called **periodontal ligament.**	▪ Present in **skull**. ▪ The bones of skull are connected together by a thin layer of fibrous tissue called **sutural ligament**. ▪ They obliterated in **old age**



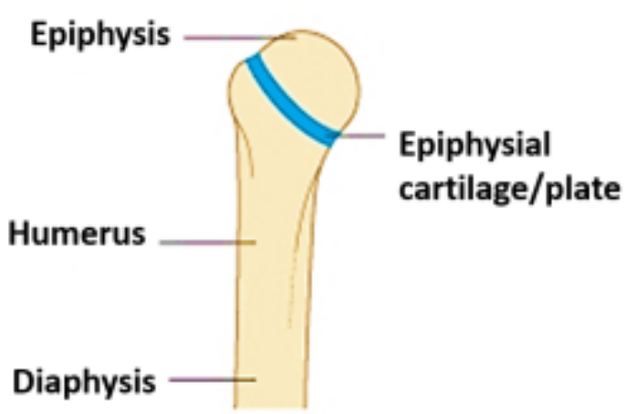


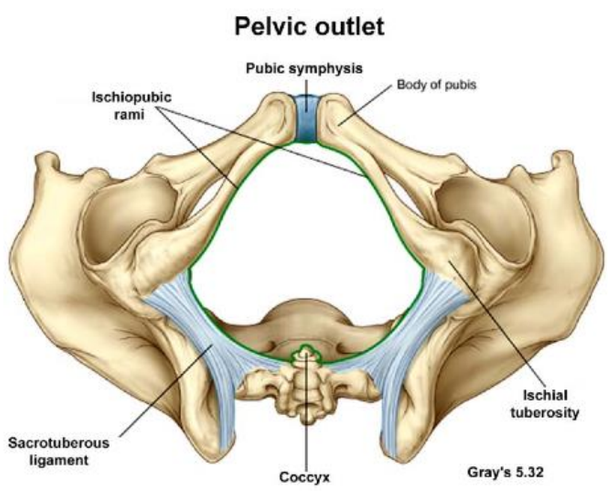


II. The Cartilaginous Joints: (false joint)

- In these joints the **surfaces** of the articulating bones are **connected** together by a disc of **cartilage**.
- They are **2 types**:

1-Primary cartilaginous joint	**2- Secondary cartilaginous joint**
▪ **Temporary** joint disappears by ossification of epiphyseal cartilage. ▪ **Site:** at the ends of long bones. ▪ **Fixed** joint. ▪ **Structure :Epiphyseal plate** of hyaline cartilage between the epiphysis and metaphysis in the developing long bones in children.	▪ **Permanent** joint. ▪ Present in the **midline** e.g. inter-vertebral discs & symphysis pubis . ▪ **N0 or limited** movement which is allowed by the **elasticity** of the fibrocartilaginous **disc**. ▪ The articulating **bone** is **covered** by a thin layer of **hyaline** cartilage and are **separated** by white **fibrocartilagenous** disc. It is **strengthened** by fibrous ligaments, which fuse with the periphery of the cartilaginous discs .





III. Synovial Joints:

- They are **mobile** joints present mostly in the **limbs .**
- **Structure of synovial joints:**

1) Fibrous capsule :

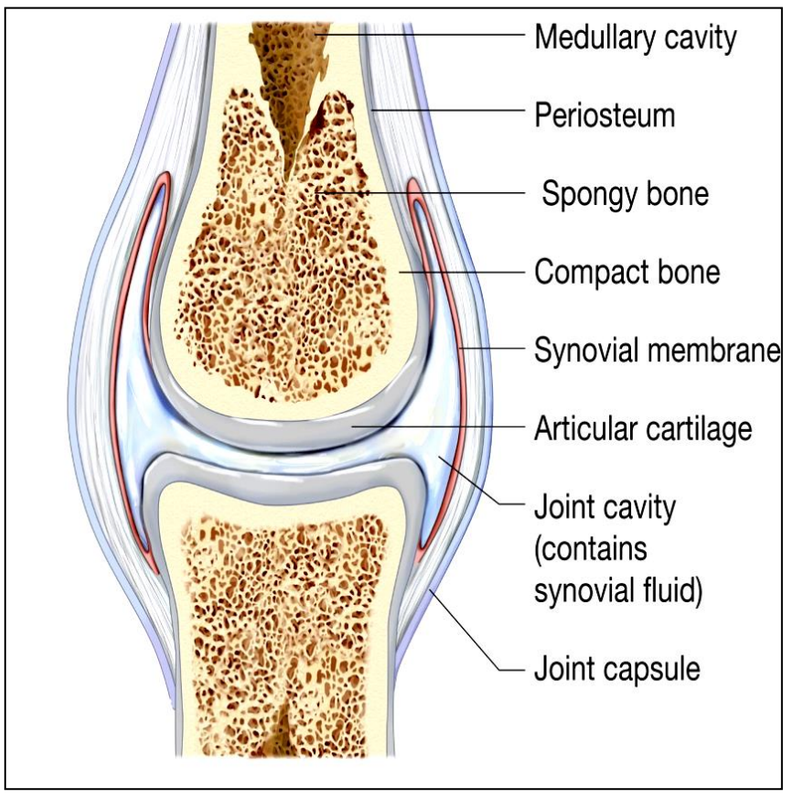
- The synovial joint is **surrounded** completely by a fibrous capsule which is **lined by** synovial membrane.
- This capsule is **supported** and strengthened by **ligaments .**
- It is **pierced** by blood vessels and nerves which supply the joint.

2) Articular cartilage :

- **Hyaline** cartilage **covers** the articular surfaces of bones.
- It is very **smooth** and is **lubricated** by the synovial fluid.
- **Nutrition**: From synovial fluid.
- It has **no** blood or nerve supply.
- ***Applied anatomy :*** In old age it shows irregularities and erosions. The eroded areas do not repair with pain & limitation of movements .This disease is called osteoarthritis .

3) Joint cavity:

- It is a **potential** cavity which appears if fluid, blood or pus collects into it.
- Normally it **contains** a very thin film of synovial fluid.



4) Synovial membrane :

- Thin, moist , **smooth** and glistening membrane that **covers** all structures inside the joint **except** the articular surfaces .
- It also **lines** the fibrous capsule.
- It secretes and absorbs the **synovial fluid**.

5) Synovial fluid:

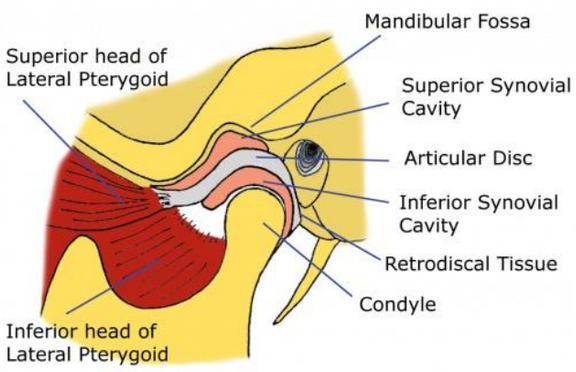
- Pale yellow **viscous fluid** similar to egg-albumin.
- It **contains** free cells (synovial cells, macrophages and lymphocytes).
- ***Functions:***
  - **Lubrication & nutrition of** the articular cartilage.
  - Prevents **erosion** of articular cartilage.

6) Ligaments:

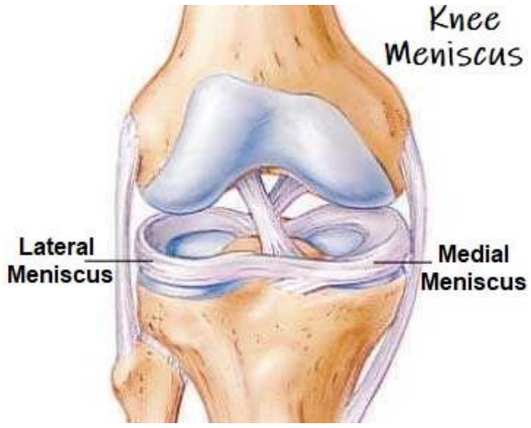
- **Extracapsular** and **intracapsular** ligaments which **support** and **strength** the joint.

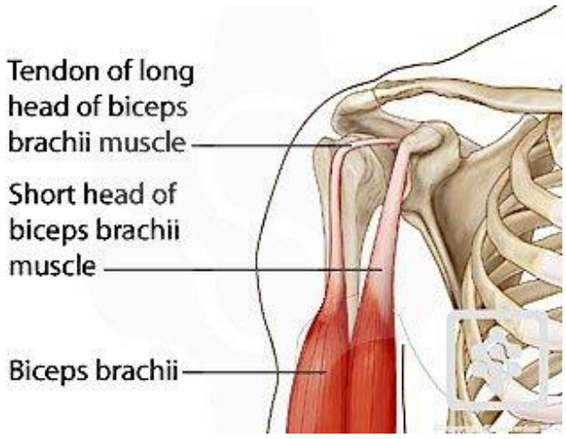
7) Structures which may be present ***inside the cavity of synovial joints:***

1- ***Articular disc:*** Disc of **fibrocartilage** which **divides** the joint cavity into two compartments (upper and lower) e.g. temporo-mandibular joint.



The Temporomandibular Joint





2- ***Menisci (semilunar cartilages):*** e.g. the two semilunar plates of **fibrocartilage** present **inside** the knee joint.

3- ***Ligament:*** e.g. **cruciate** ligament inside the **knee** joint.

4- ***Tendon:*** e. g. the tendon of long head of **biceps** muscle inside the **shoulder** joint.

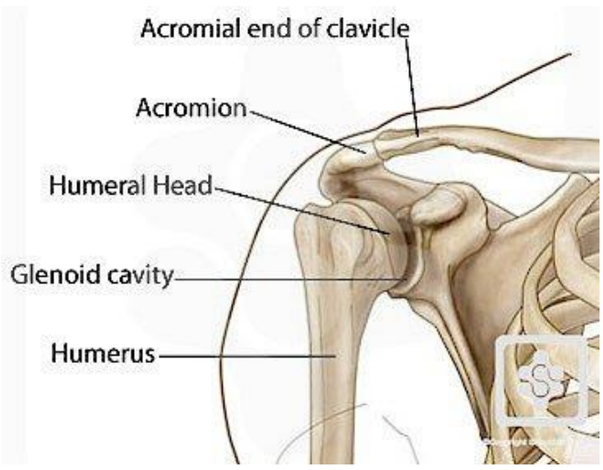
★ ***Factors affecting the stability of the joint:***

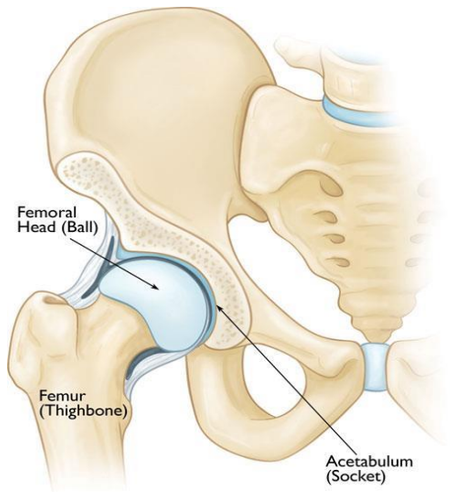
1- Shape and fitting of **articulating surfaces**.

2- Thickness and strength of the **capsule**.

3- Position and strength of **ligaments**.

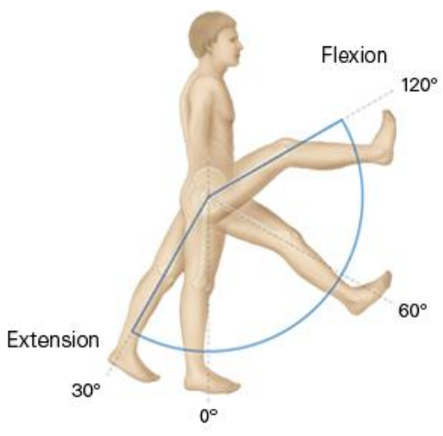
4- Strength of **muscles** surrounding the joint.

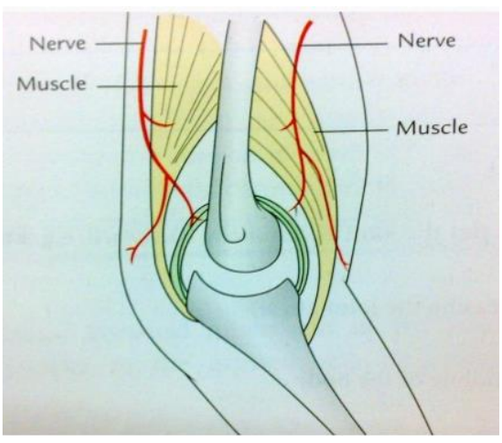




- **Factors affecting the range of movement:**

1. Tension of capsule , ligaments & structures surrounding the joint.
2. Contraction of the antagonistic muscles.
3. Approximation and contact of the articulating bones and soft tissues around the joint.

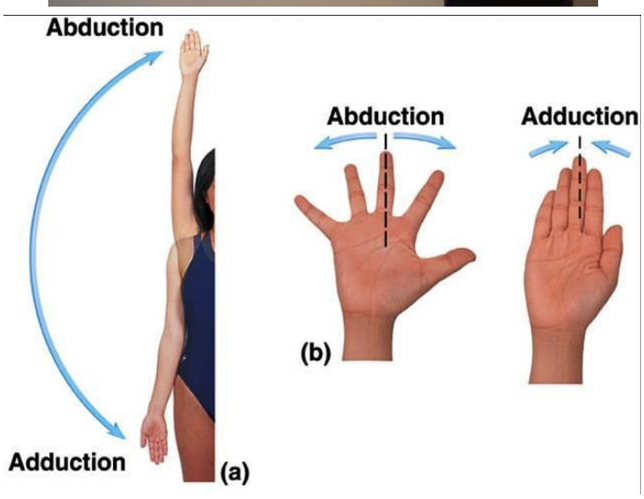




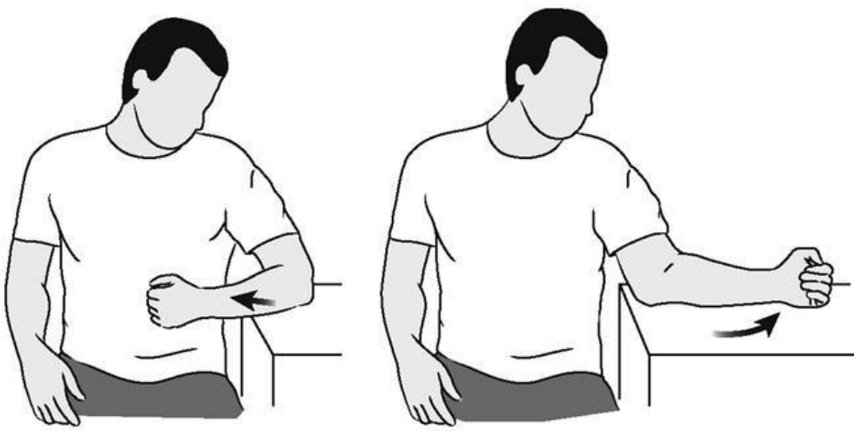
- **Nerve supply of joint:**
  - The **sensory** nerves which supply the joint are called **articular nerves**, which end in the fibrous capsule and related ligaments. They are sensitive to **pain, sense of position and movement** of joint.
  - **Hilton's Law:** The nerve supply to a **muscle acting** on a specific joint gives a branch to supply this **joint** and another branch to supply the **skin covering** the same joint.

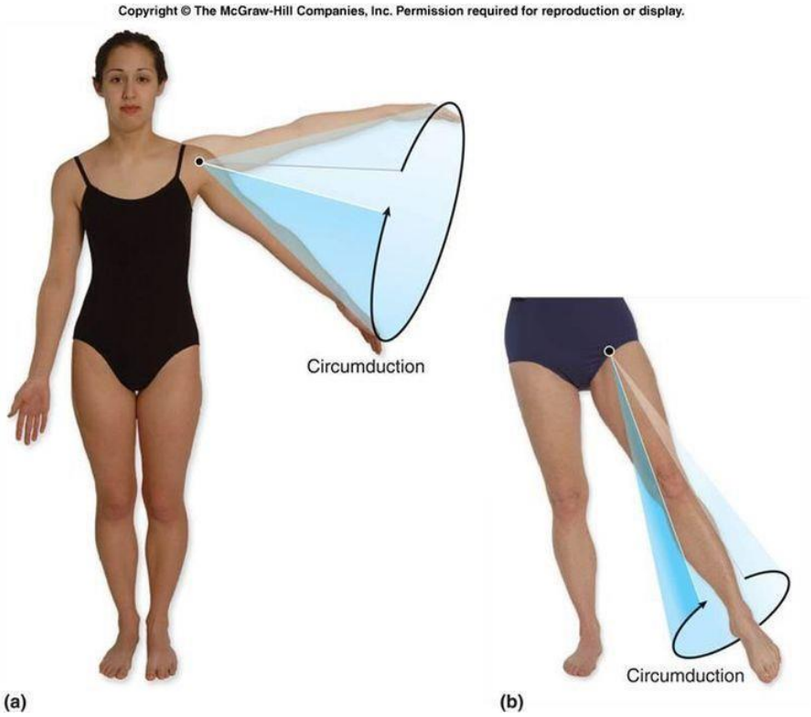
Movements of the Joints

1. **Flexion:** Approximation of two ventral surfaces to each others (bending).
2. **Extension:** the two ventral surfaces move away from each other (Straightening).
3. **Abduction:** Movement of the limb laterally away from the middle line. In the fingers moving away from the center of middle finger while in the toes moving away from the center of second toe.
4. **Adduction:** Movement of the limb medially towards the middle line. In the fingers moving towards the center of middle finger while in the toes moving towards the center of second toe.

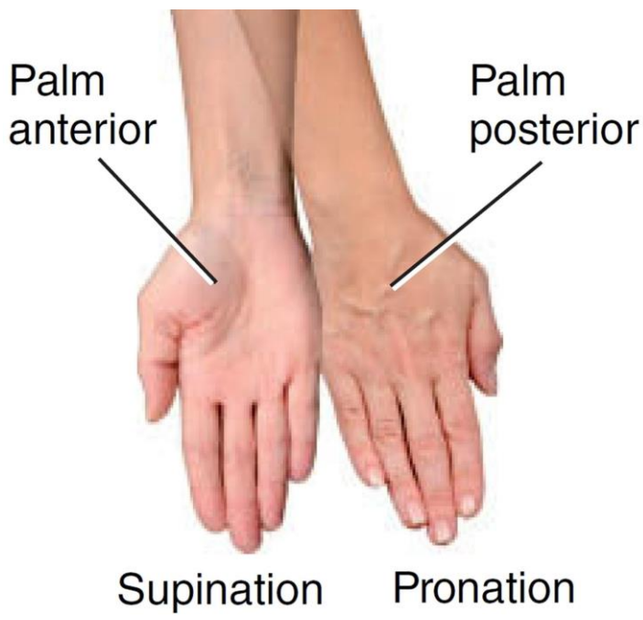


5. **Rotation:** Medial or lateral rotation of the limb around a vertical axis.
6. **Circumduction:** Combination of all above movements.





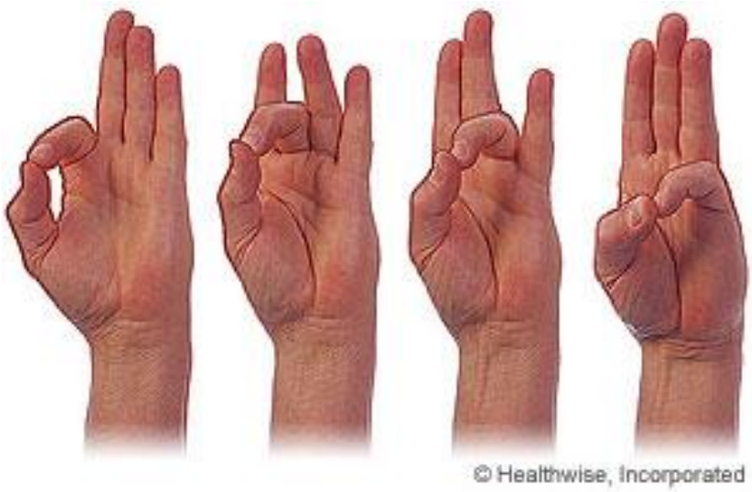
7. **Supination:** The lateral rotation of the forearm.
8. **Pronation:** The medial rotation of the forearm.



9. **Inversion:** The sole of foot is directed inwards.
10. **Eversion:** The sole of foot is directed outwards.

(b) Inversion (c) Eversion

11. **Opposition:** The thumb come in contact with the other 4 fingers.

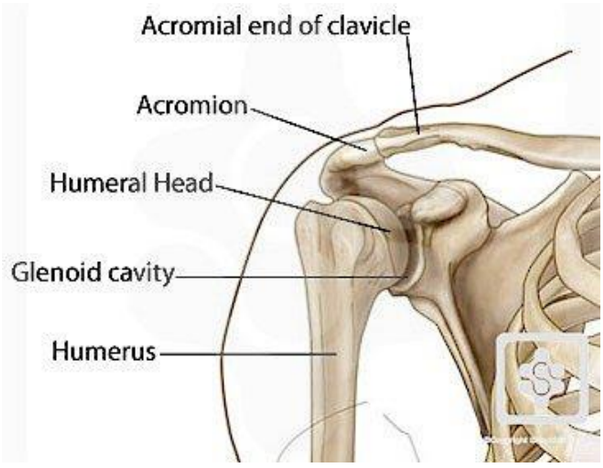


★ **Classification of Synovial Joints :**

A- According to the number of articulating bones:

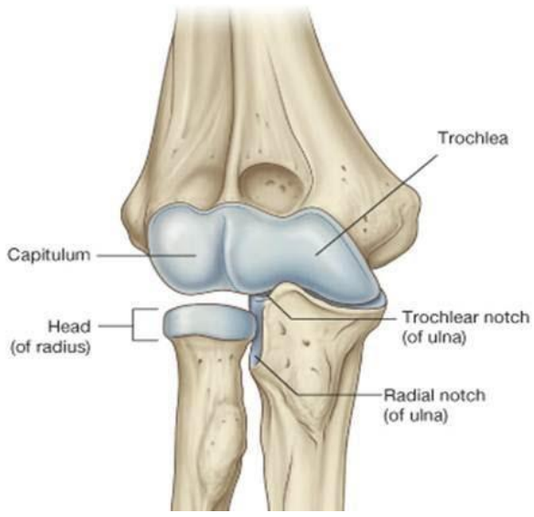
1. **Simple** joints: Between two bones e.g. shoulder.
2. **Compound** joints: Between more than two bones e.g. elbow.
3. **Complex** joints: Contain intra-articular structures e.g. knee joint.

Simple joint
(Shoulder joint)



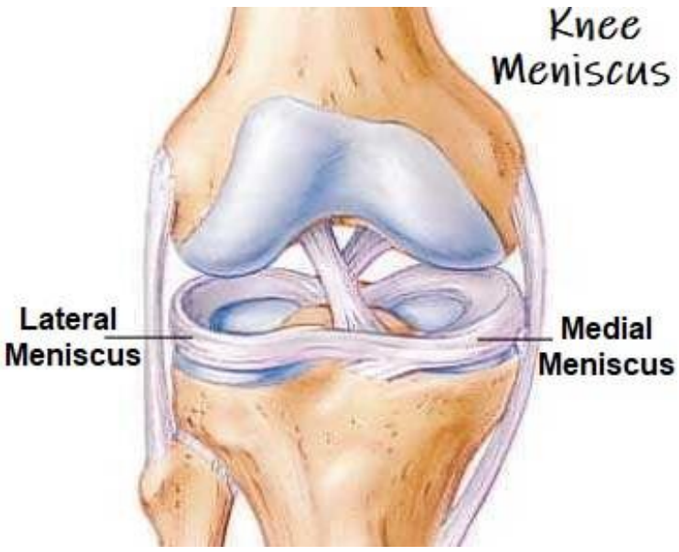
Compound joints

(Elbow joint)



Complex joints

(knee joint)



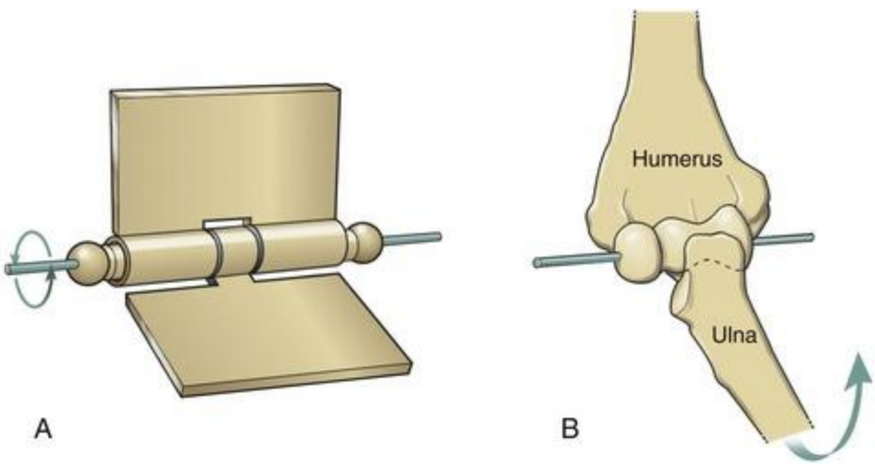
B- According to the axis of movement:

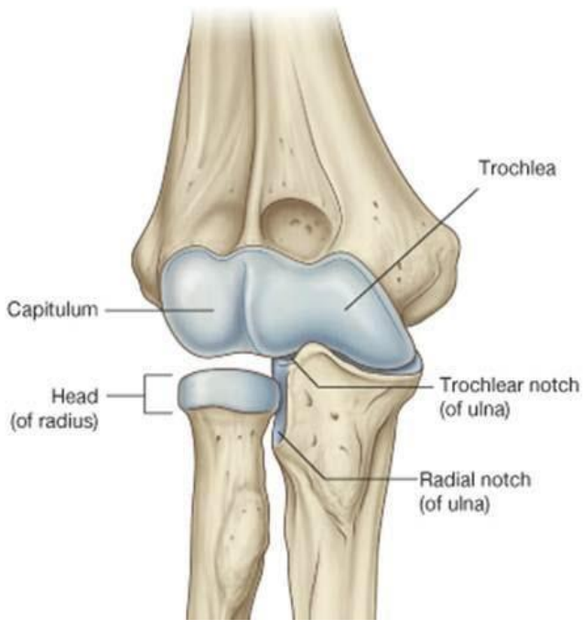
I. Uni-axial joints:

- In this type of joints the movements take place around a **single axis**.
- According to the **direction of axis**: there are 2 types:

1-Hinge joint:

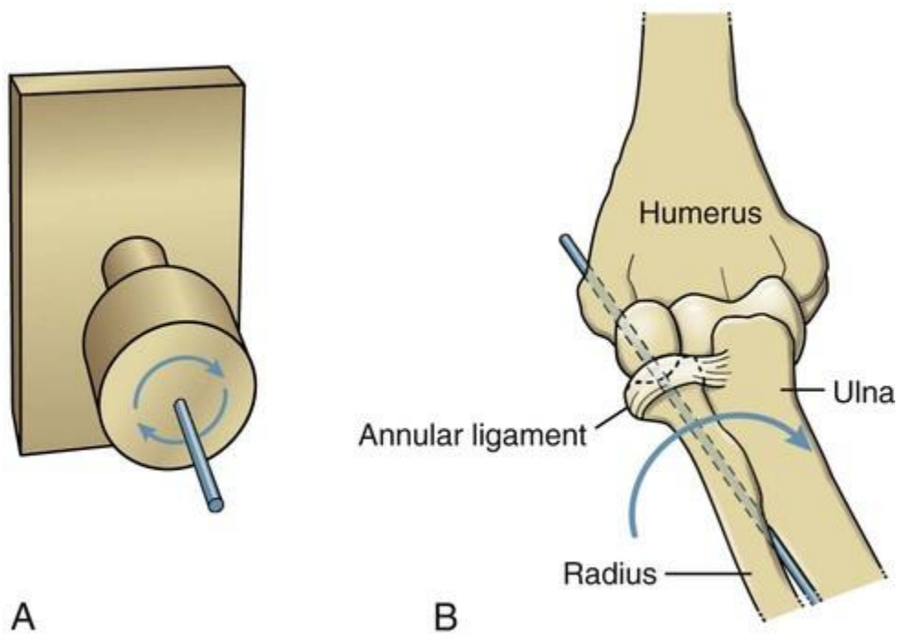
- The joint is uni-axial with **one transverse axis** e.g. elbow joint .
- A convex **trochlea** articular surface articulates a deep concave surface .
- The **movement** is flexion and extension only with no abduction or adduction due to strong **collateral ligaments** e.g. elbow.

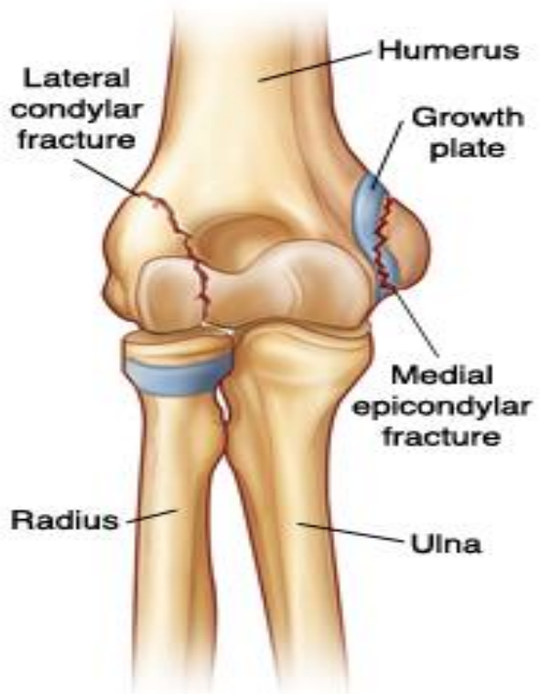




2-Pivot joint:

- The joint is uni-axial with **one** vertical **axis** e.g. superior radio-ulnar joint.
- The **articulating surface** consist of a central bony pivot (axis) surrounded by a fibro-osseous ring .
- The **movement** of this joint is rotation around the center of the pivot. i.e **pronation and supination** .



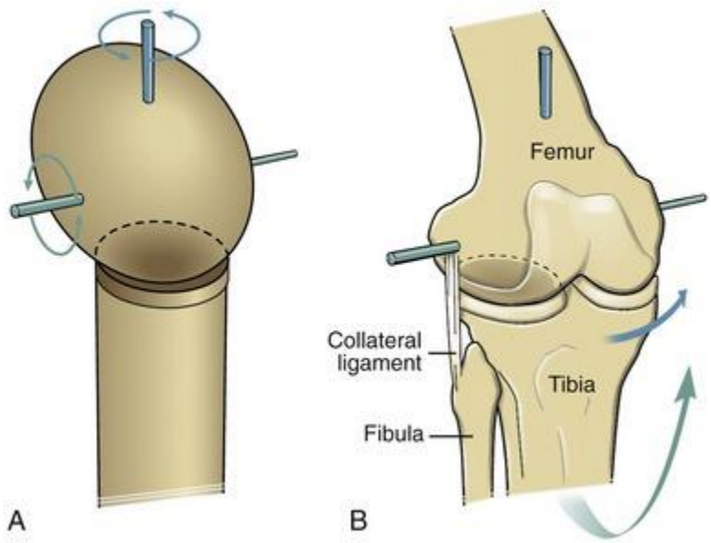


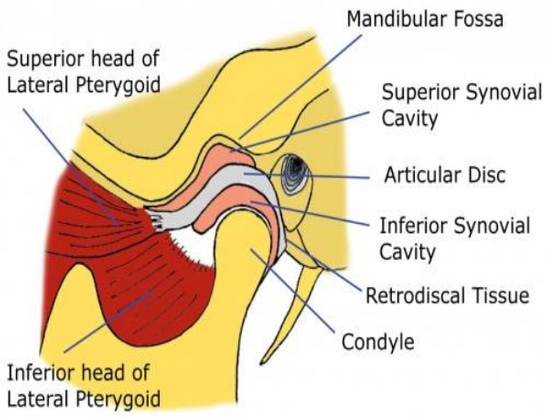
II. Bi-axial joints:

- In this type of joints the movements take place around **2 axes perpendicular to each other.**
- According to the **shape of the articular surface** there are ***3 types:***

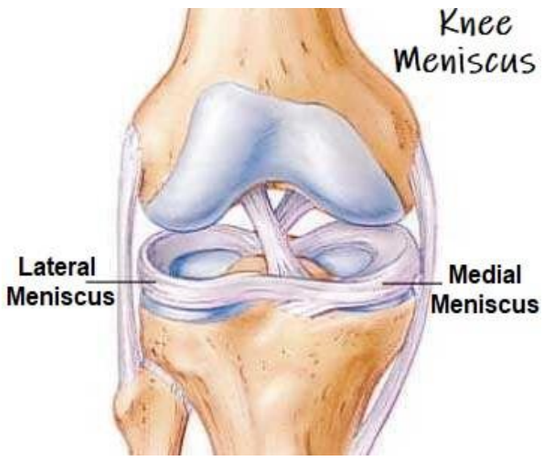
1- ***Condylar and bicondylar joint:***

- It consists of either **2** separate convex surfaces (condyles) which articulate with 2 concave surfaces, e.g. knee joint or **one** condyle articulating with one concave surface e.g. temporo-mandibular joint.
- The **movements** of this joint are flexion , extension and rotation (medial and lateral)



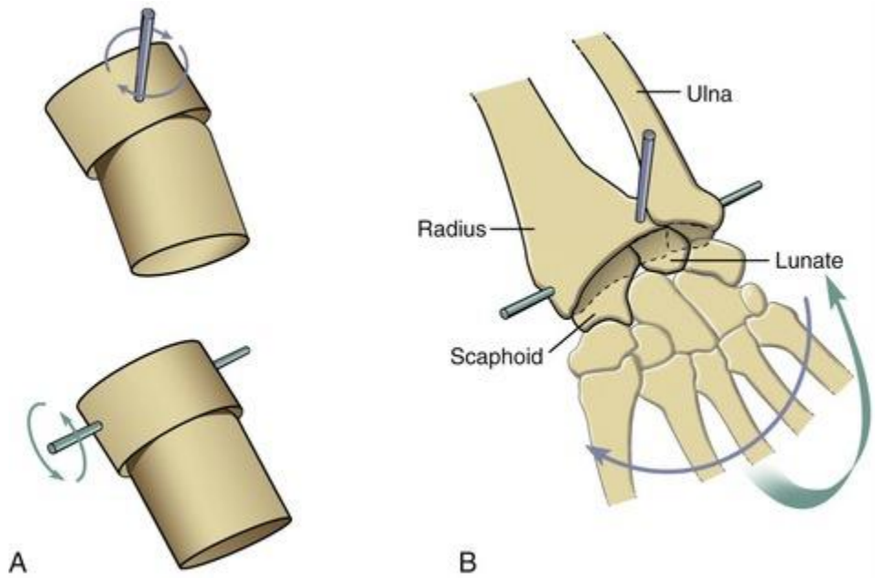


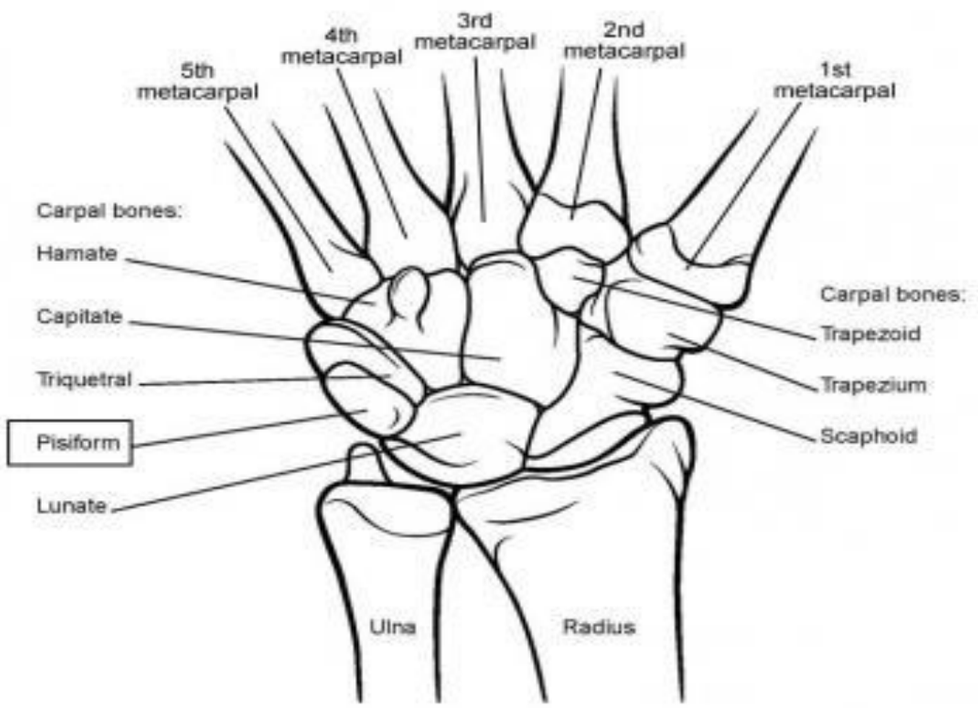
The Temporomandibular Joint



2- ***Ellipsoid joint:***

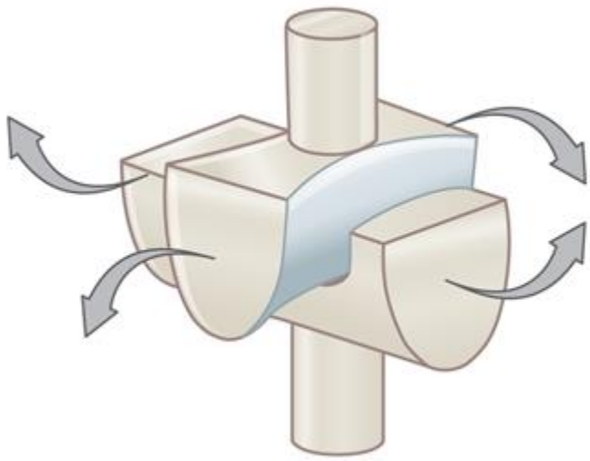
- It is formed by the articulation of an **oval convex** surface (carpal bones) with an **elliptical concave** surface (inferior surface of radius and the articular disc of ulna) e.g. **wrist joint**.
- The **movements** of this joint are flexion , extension , abduction , adduction and circumduction .

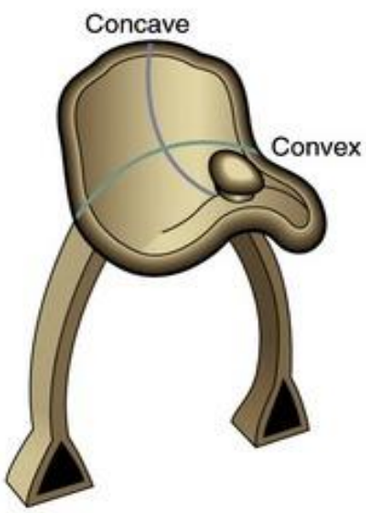


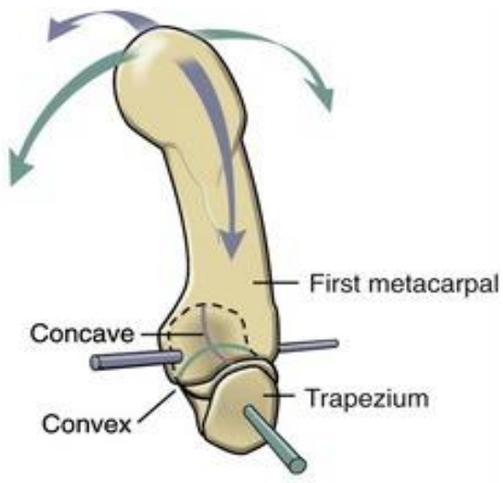


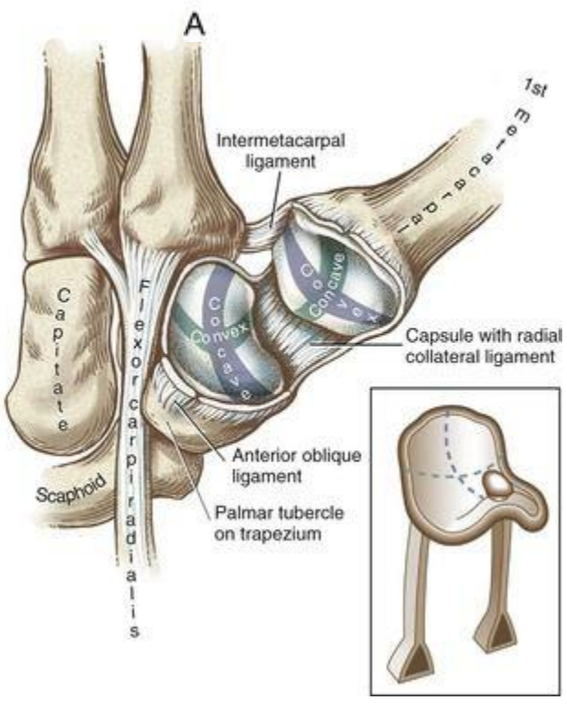
3- ***Saddle joint:*** (cow boy riding his horse)

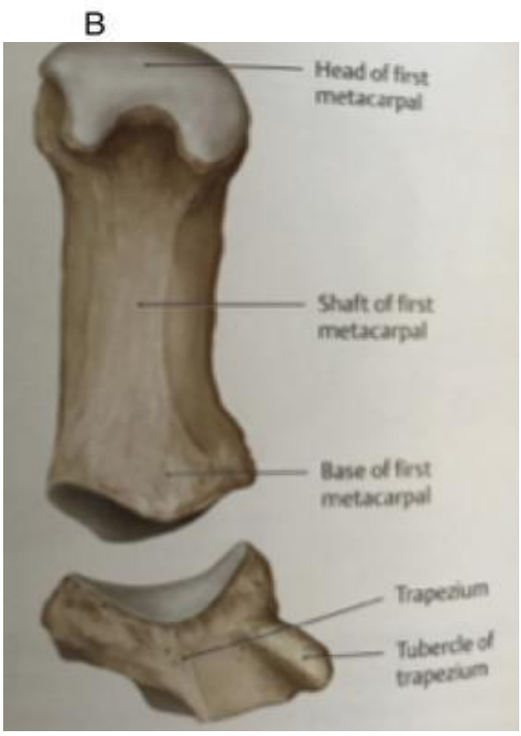
- The articulating surfaces of this joint are 2 **concavo-convex** surfaces . e.g. **carpo-metacarpal** joint of thumb.
- The **movements** of this joint are flexion , extension , abduction , adduction, opposition and circumduction .





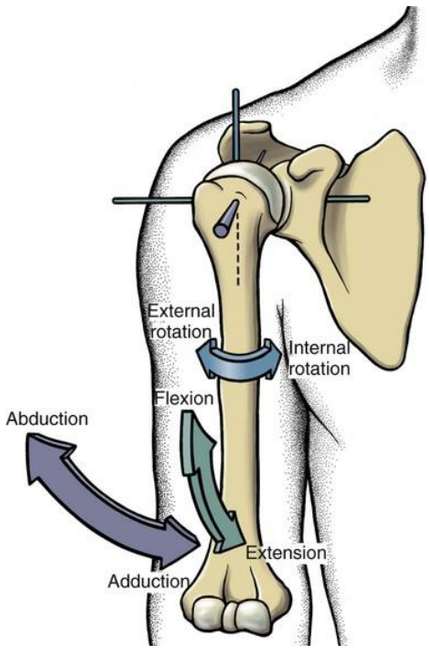


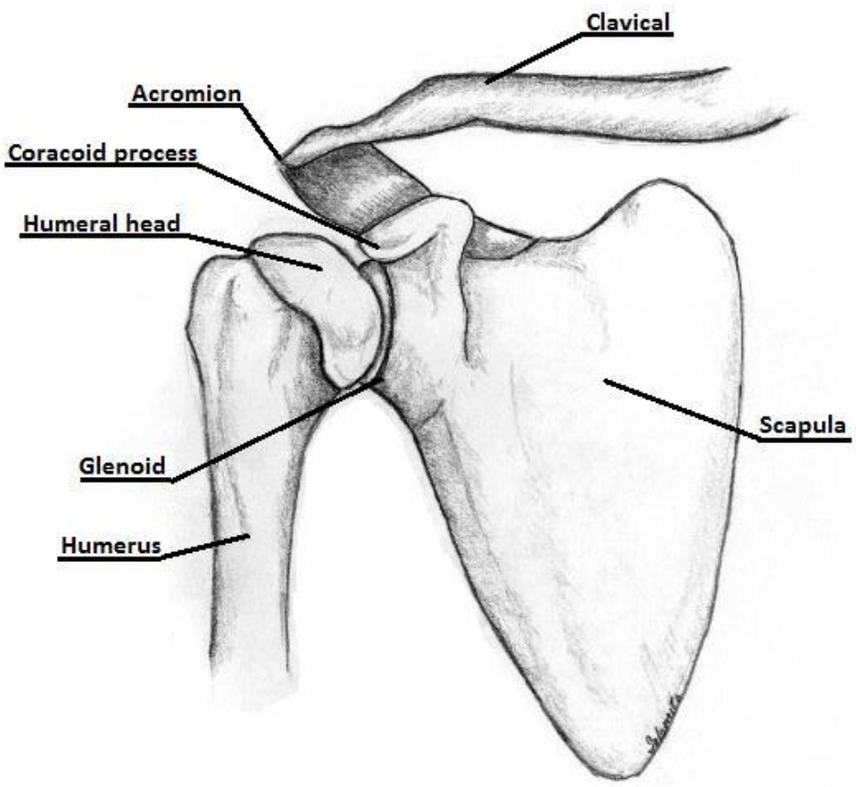


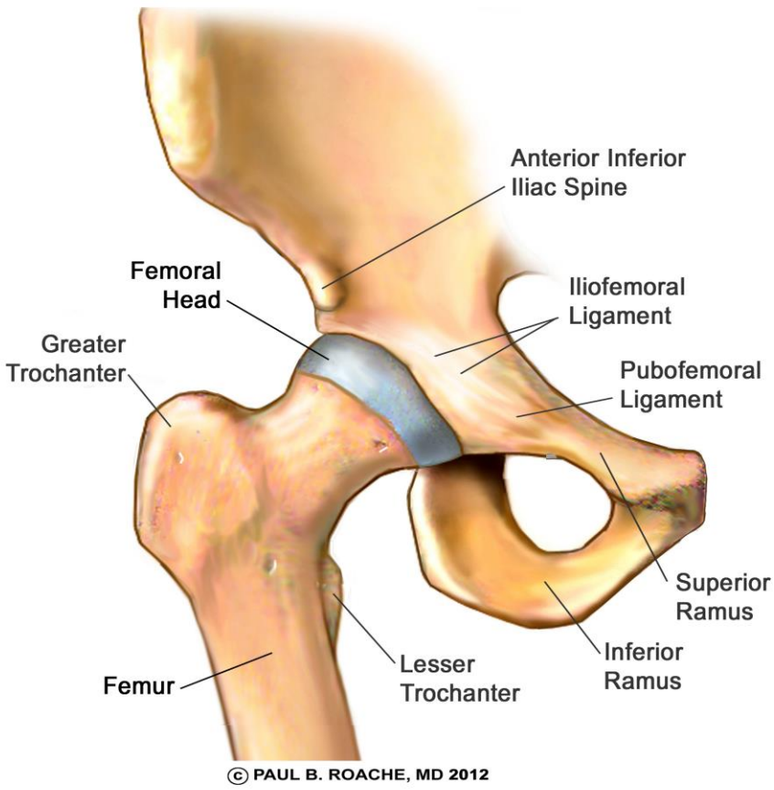


III. Multi-axial joints:

- In this type of joints, the movements occur around **3 axes .**
- The **artiuclar surface** consists of **globular** rounded bone articulates with **concave socket**. According to the **shape** of the articular surfaces, they are called **ball and socket joints** e.g. **shoulder** and **hip** joints.
- They are the **most freely mobile** joints in the body.
- The **movements** of this joint are around **transverse axis (**flexion & extension), around **antero-posterior axis** (abduction & adduction) , around **vertical axis** (medial & lateral rotation) and circumduction .

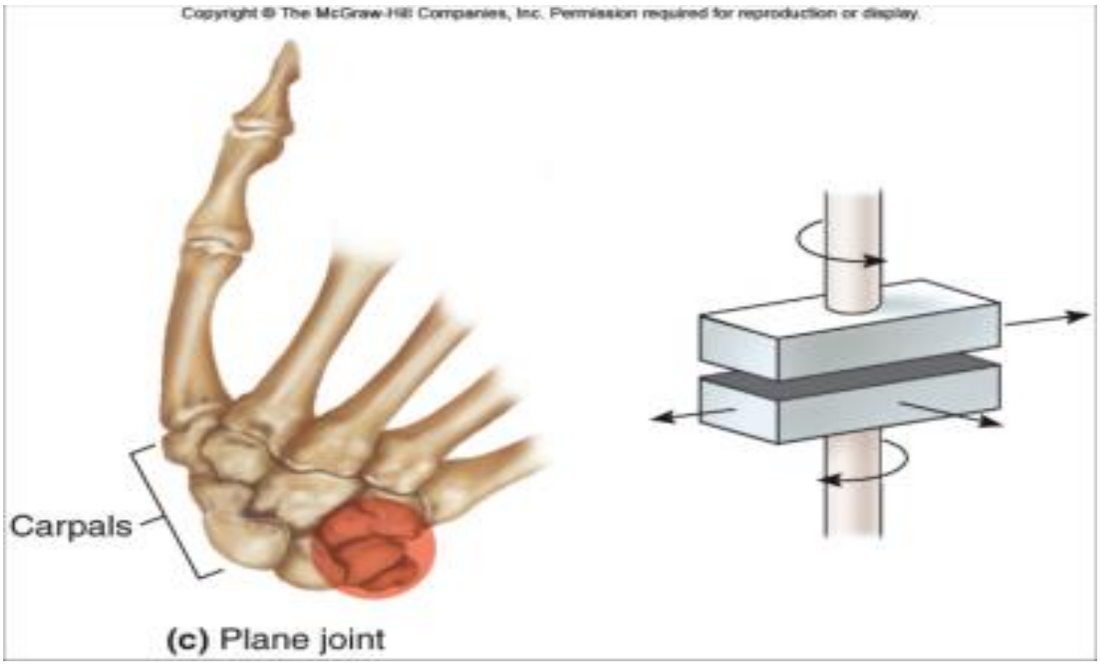






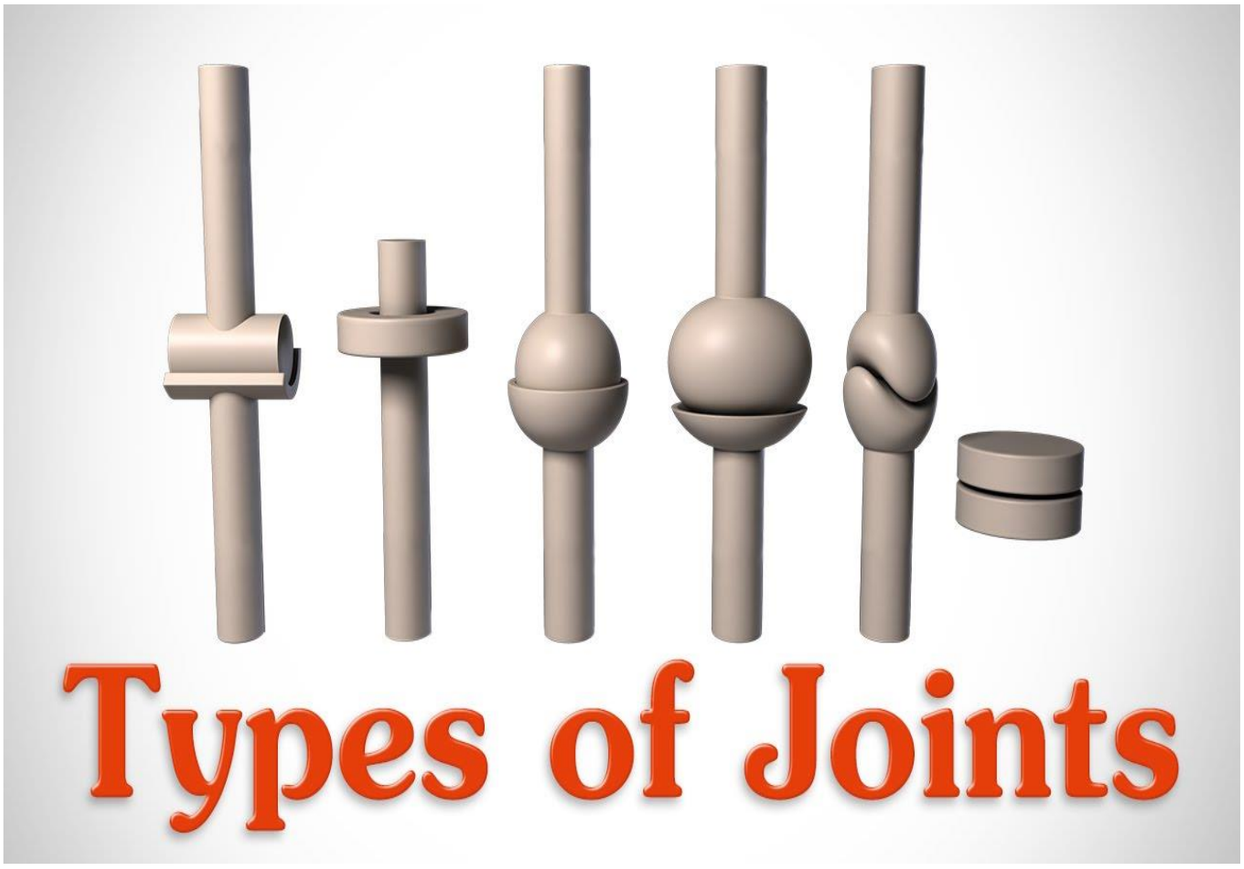
IV. Non-axial (plane) joints:

- The articular surfaces of these joints are **flat** and the movement is **gliding** without any axis of movement e.g., intercarpal joints



Sammary of types of synovial joints

According to the axis of movement.	According to shape of the articular surface
I. Uni-axial joints	1- Hinge e.g. elbow joint
	2- Pivot e.g. superior R.U. joint
II. Bi-axial joints	1- Condylar e.g. knee -T.M. joint
	2- Ellipsoid e.g. wrist joint
	3- Saddle e.g. carop-metacarpal joint of thumb
III. Multi-axial joints	★ Ball and socket e.g. Hip & shoulder
IV. Non-axial joints	★ Plane joints e.g. intercarpal joint.



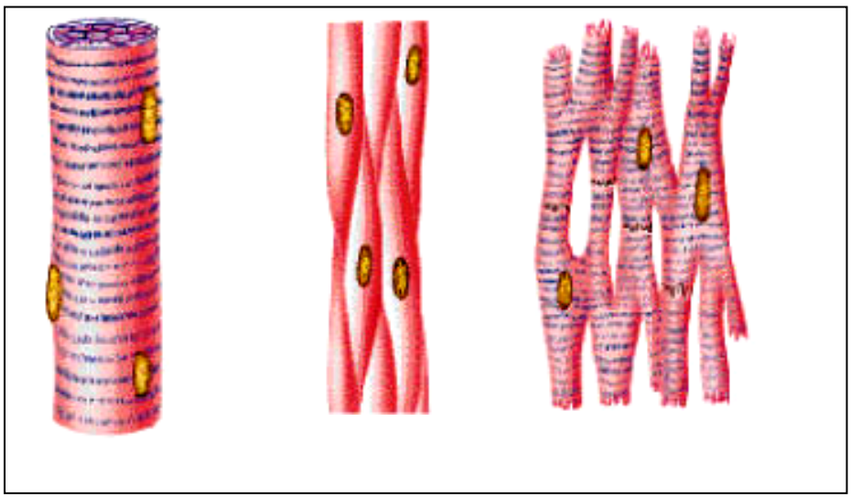
★ Please see this excellent video :

https://www.youtube.com/watch?v=0cYal_hitz4

Muscular System

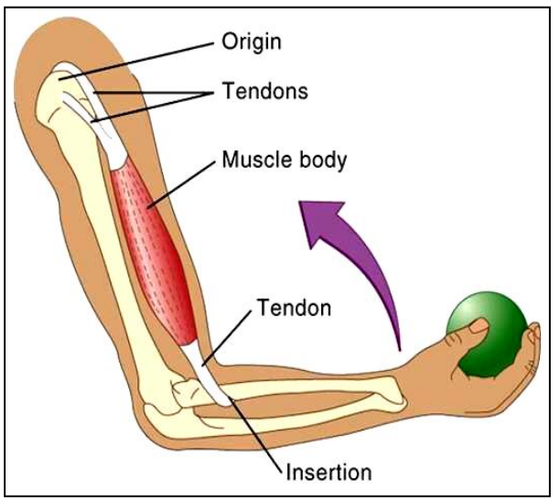
* Muscle tissue is characterized by the property of **contraction** which is the ability of the muscle fibers to **become short**.
* **Classification of the muscles** according to the structure and function, there are 3 types of :

Muscle	I. Skeletal	II. Smooth	III. Cardiac
1- Site	Attached to skeleton (bones)	In the wall of blood vessels and viscera.	In the myocardium.
2- Contraction	Voluntary	Involuntary	Involuntary
3- Striations	Present	Absent	Present but less than skeletal muscle
4- Nerve supply	Somatic nerve	Autonomic nerve	Autonomic nerve
5- Muscle fiber	Multinucleated with peripheral nuclei	Spindle-shaped with single nucleus	Branch and fuse together with single nucleus.

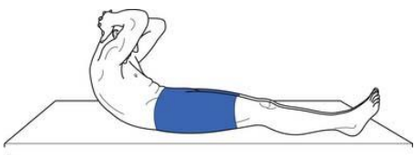


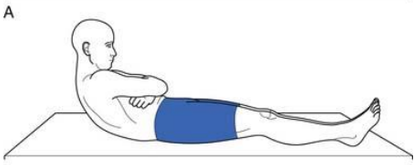
Skeletal. Smooth. Cardiac M.

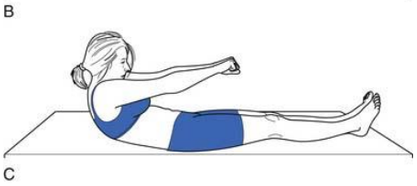
* **Attachment of skeletal muscles**: Each muscle has **two** attachments:
  - **Origin:** the most fixed attachment.
  - **Insertion:** The most mobile attachment.

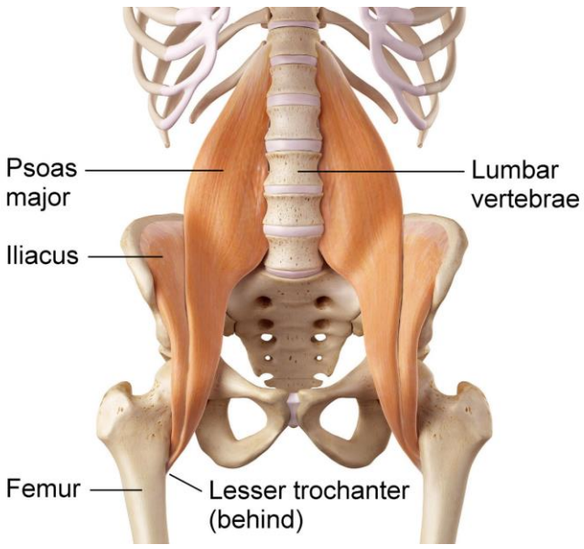


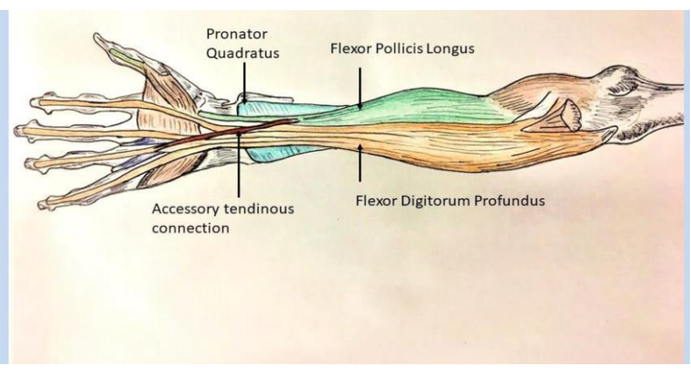
* **N.B.:**
  - **Sometimes the insertion** is the **fixed** point while the origin is the mobile one e.g psoas major muscle during raising the trunk from supine position.
  - A muscle may have **more than one point** of origin or insertion.
  - In case of limbs: the **origins** are usually **proximal to the insertions**.
  - During **contraction** of a muscle, the **insertion moves towards the origin** thus this muscle can producing a **movement in all joints** between the its origin and insertion .





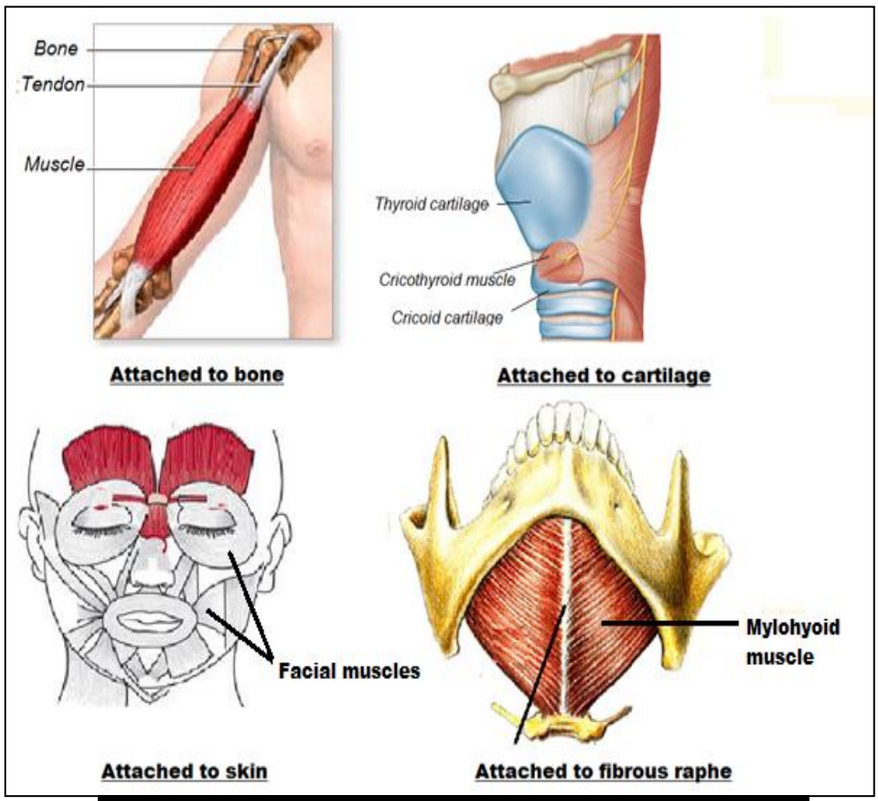


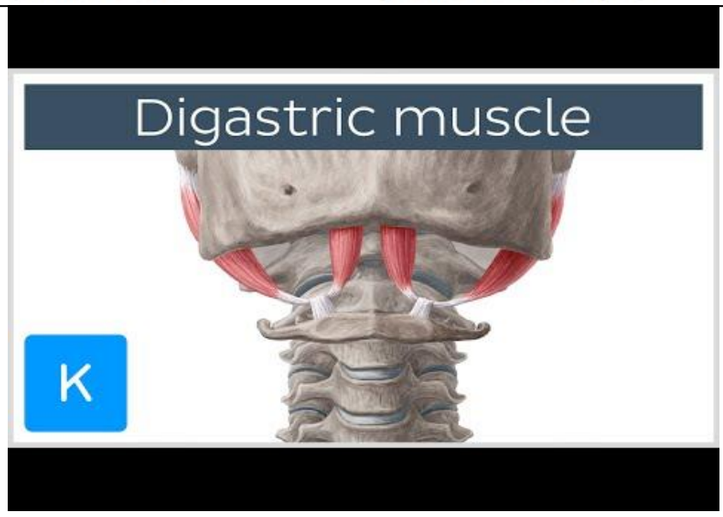




* **Types of Muscle Attachment :**

1. **Attachment to bone:** It is the commonest type. A muscle may be attached to bone either by fleshy fibers or by a tendon.
2. **Attachment to a fibrous raphe:** It is a **linear band of fibrous tissue** through which 2 muscles fuse together e.g. mylohyoid muscle.
3. **Attachment to skin:** A muscle is inserted into the dermis of the skin and by its contraction it could move the skin, e.g. facial muscles.
4. **Attachment to cartilage:** as in the muscles of the larynx e.g. cricothyroid muscle.
5. **Intermediate tendon** joins 2 fleshy bellies together e.g. digastric muscle (belly is the flesh contractile part of the muscle).





Types of muscle attachment

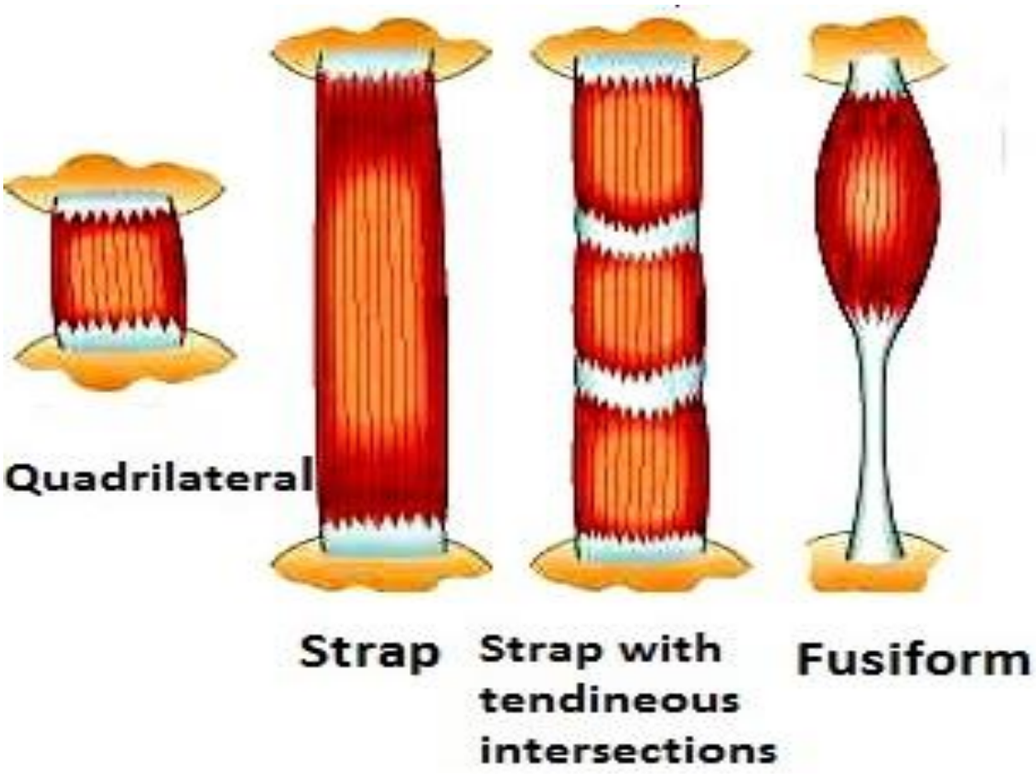
⁕ **Forms of Skeletal Muscles :**

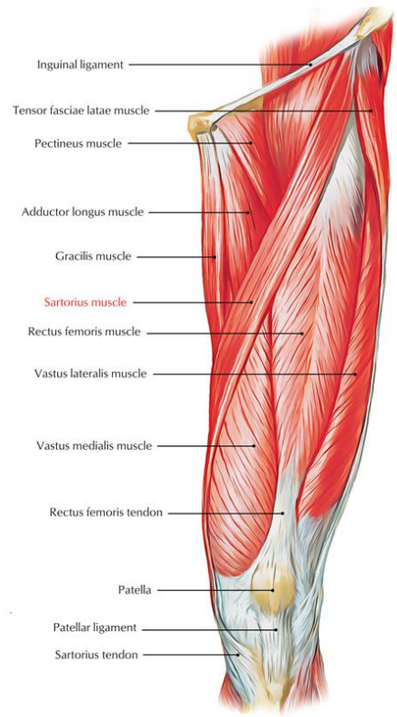
- Skeletal muscles vary in **shape** and arrangement of their fibers to produce a specific **force and range** of contraction.
- The muscle form depends on the **arrangement** of the muscle fibers in relation to the line of pull of the muscle.
- **Line of Pull:** The line of pull of a muscle is the line **extending between its origin and insertion.**
- The fibers of the muscle are either arranged **parallel** to the line of pull or **oblique** to it.

A) Muscles which have fibers lie **parallel to the line of pull**:

1- **Strap-like** muscle: e.g. sartorius muscle.
2- **Strap**-like muscle **with tendinous** intersections e.g. rectus abdominis muscle.
3- **Quadrilateral** muscle e.g. thyrohyoid muscle.
4- **Fusiform** muscle: e.g. biceps brachii muscle.

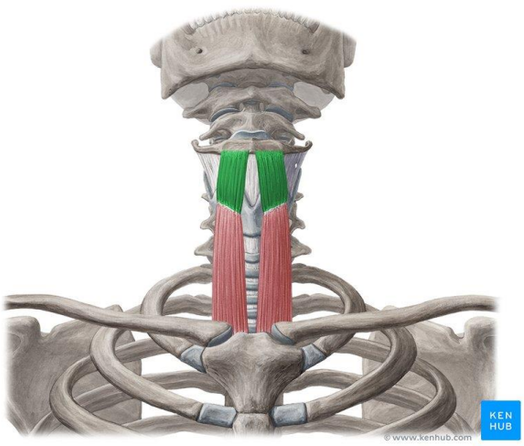
Muscles with parallel fiber



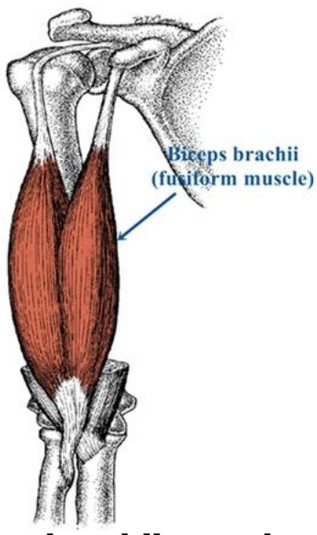


Sartorius muscle

Rectus abdominis muscle.



Thyrohyoid muscle



Biceps brachii muscle

B) Muscles which their fibers lie **oblique to the line of pull**:

I- Pennate muscles : (feather-like)

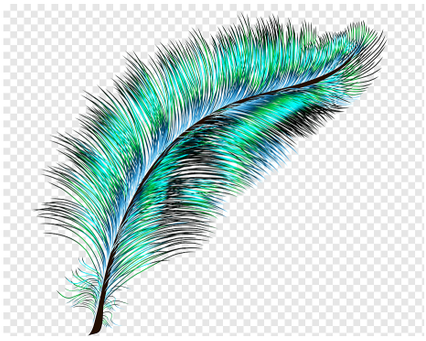
- The muscle fibers lie **oblique** to the tendons, they are **4 types**:

a-**Unipennate** muscles: The fibers lie on **one side** of the tendon, e.g. flexor pollicis longus muscle.

b-**Bipennate** muscles: The fibers lie on **both sides** of the tendon, e.g. rectus femoris muscle.

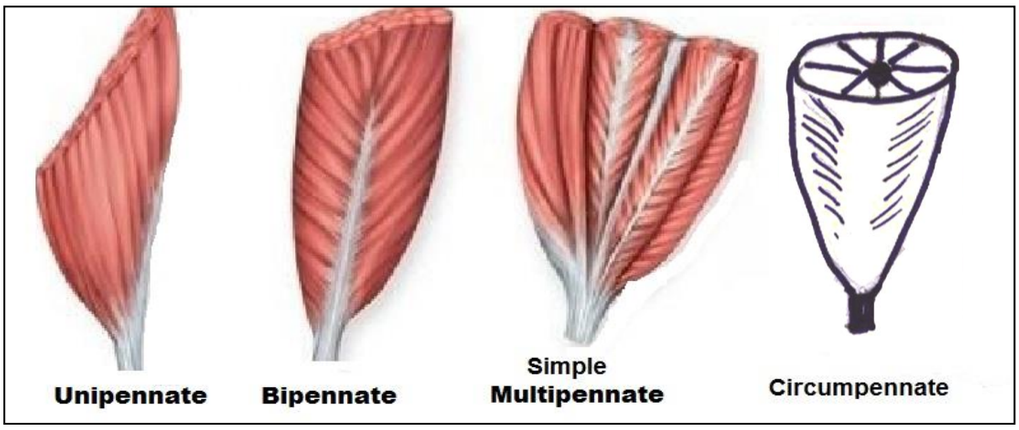
c-**Multipennate** muscles: Each is formed of many **bipennate** units lying **beside** each other e.g. Deltoid muscle.

d- **Circumpennate** muscles: Each muscle is **cylindrical** with a **central tendon** and **bipennate units converging** from the periphery towards the tendon e.g. tibialis anterior muscle.

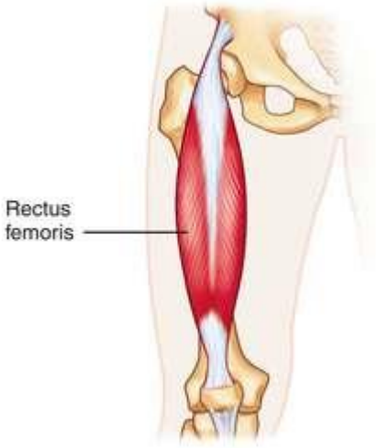


Feather

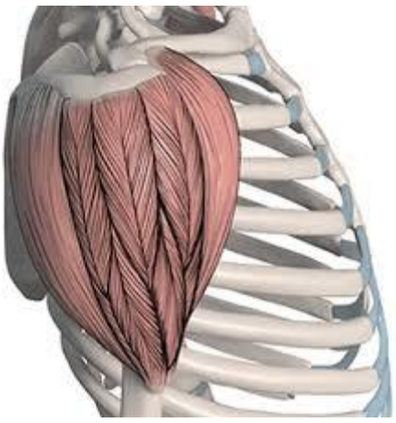
Idea of circumbinate



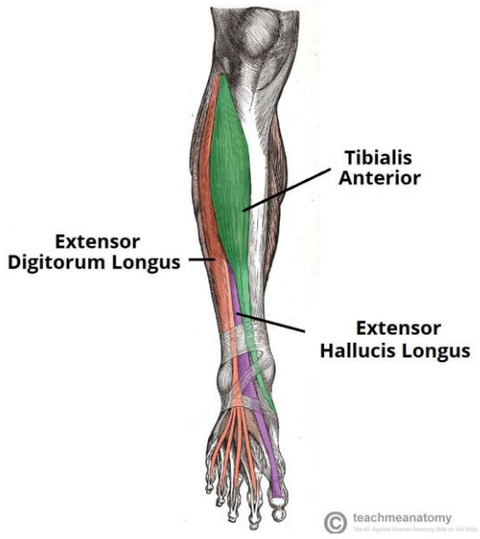
Flexor pollicis longus muscle



Rectus femoris muscle

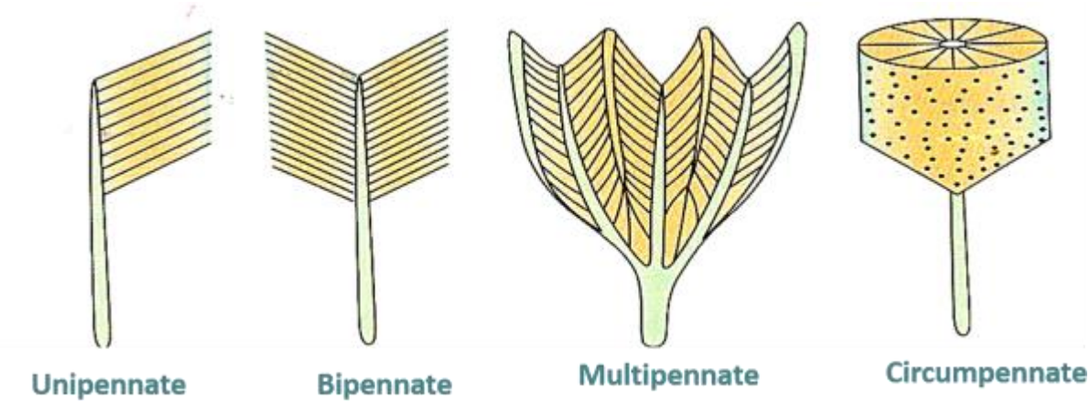


Deltoid muscle



Tibialis anterior muscle

Muscles with oblique fibers



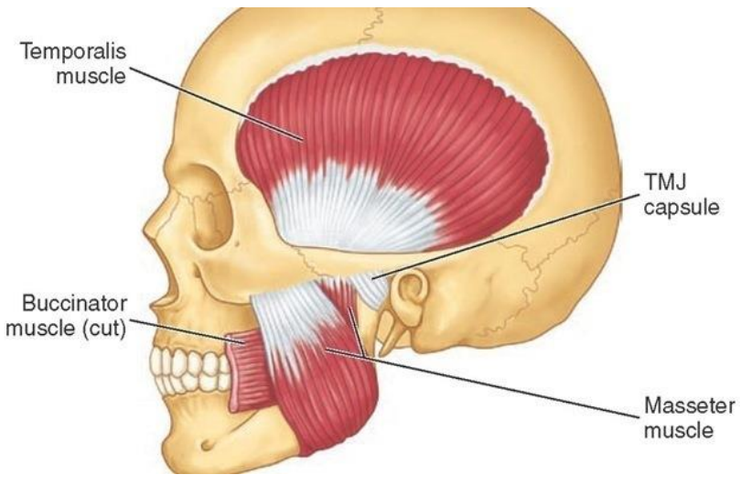
II. Non-pennate fibers:

a. **Triangular** muscles e.g. temporalis muscle.

b. **Cruciate** muscles e.g. masseter muscle.

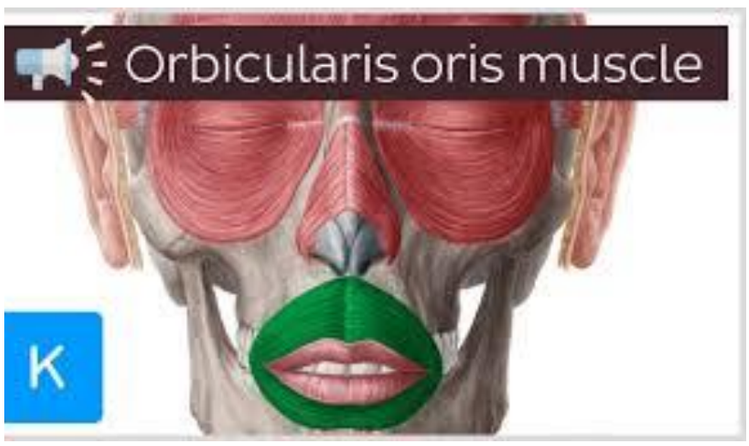
c. **Spiral** muscles e.g. supinator muscle.

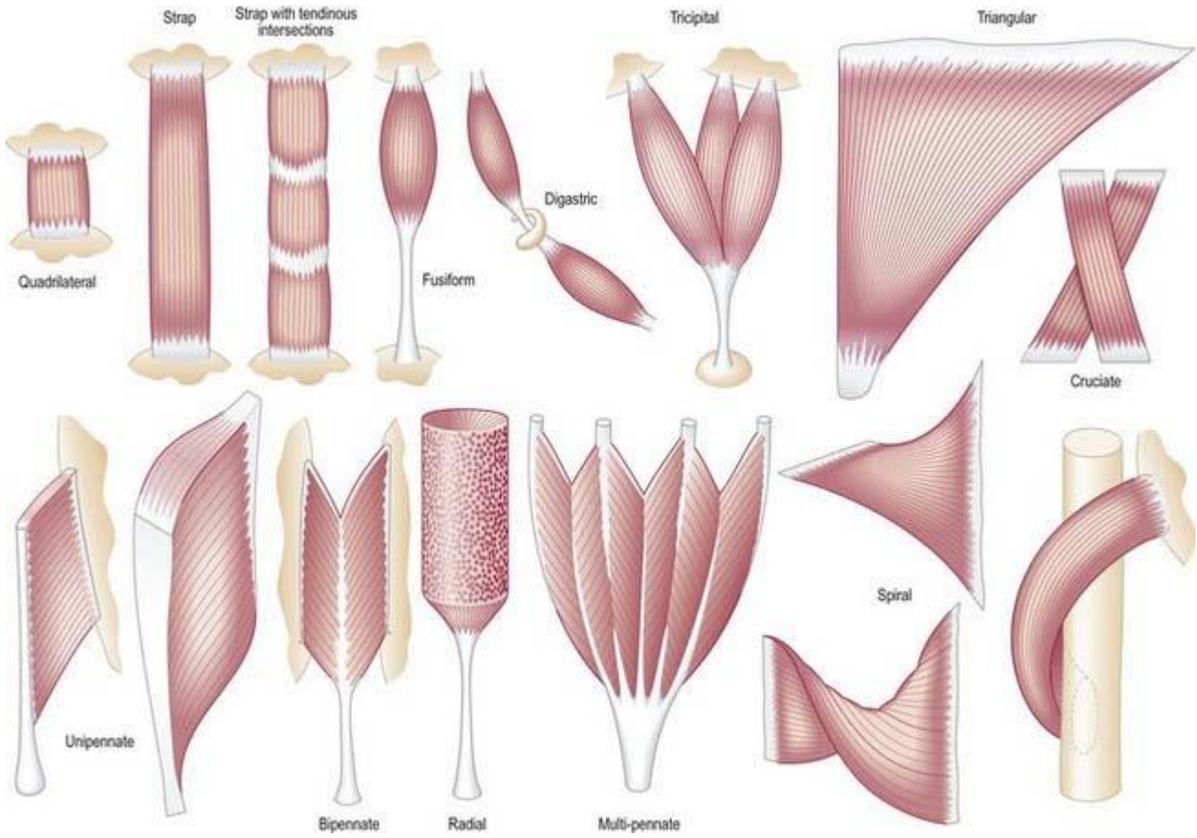
d. **Circular** muscles e.g. orbicularis oris.



Temporalis & Masseter muscles

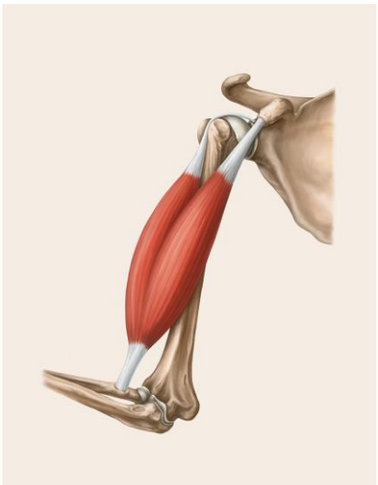
Supinator muscle





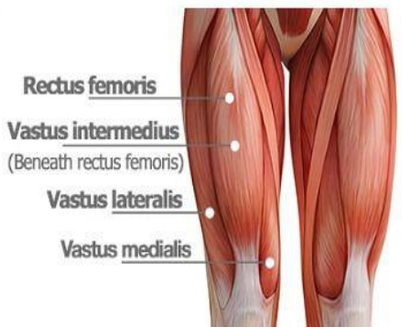
Summary of forms of muscles

* Muscles having **more than one head**:
  1. A muscle having **two** heads e.g. **bi**ceps muscle.
  2. A muscle having **three** heads e.g. **tri**ceps muscle.
  3. A muscle having **four** heads e.g. **quadr**iceps muscle.



Biceps muscle

Triceps muscle



Quadriceps muscle

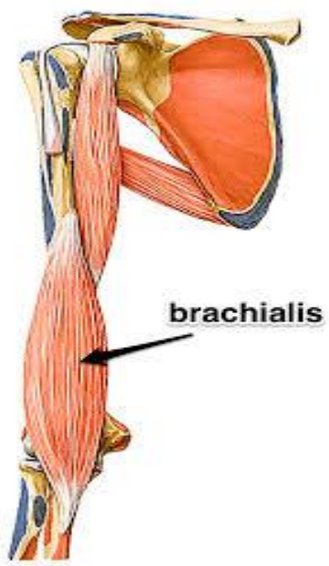
Muscles having more than one head

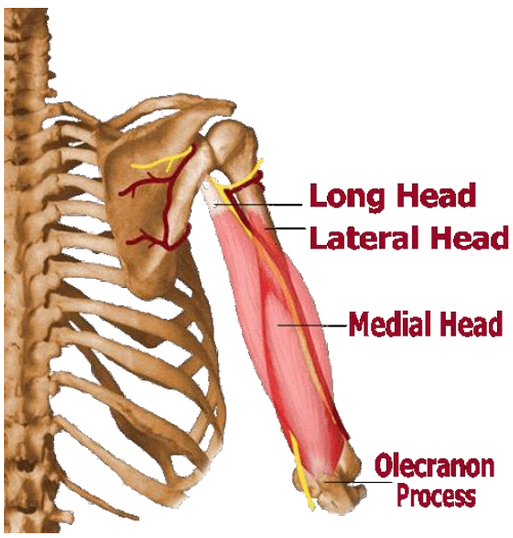
✳ **Types of the Muscle Action :**

- Any **movement** is not done by the action of one muscle but by a **group** of muscles which should **act and coordinate** together.
- According to the role of the muscle, there are **4 types** of muscle actions:

1- Prime mover:

- The muscle which **initiates and maintains** a movement e.g.
  - ♣ **Brachialis** muscle which is a prime mover for **flexion** of the elbow joint.
  - ♣ **Triceps** muscle is a prime mover of **extension** of the elbow joint.





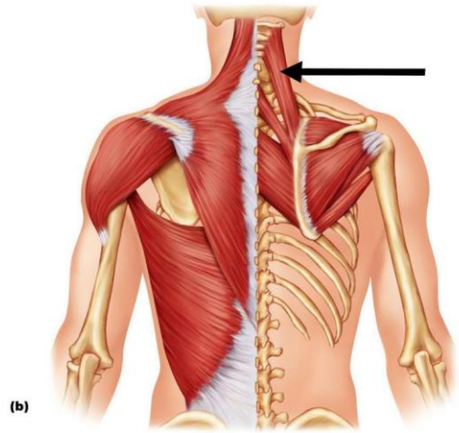
2- Antagonist:

- The muscle which **opposes** the action of the **prime mover**.
- For example **brachialis** muscle and **triceps** muscle are antagonists during flexion & extension of elbow joint .

3- Fixator (Stabilizer):

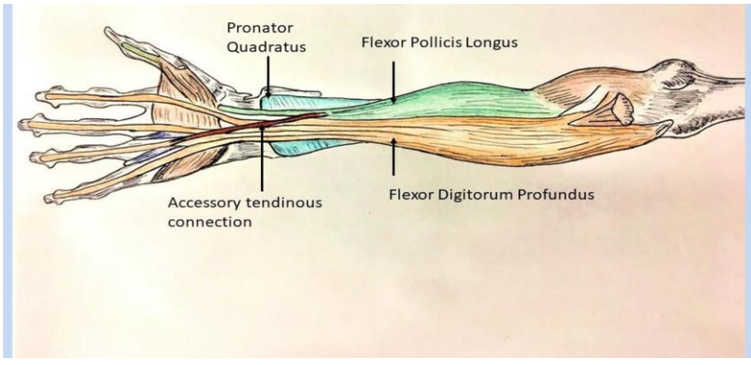
- The muscles which **fix the origin** of the prime mover or stabilize **the joint** upon which the muscle acts.
- For example the **muscles around the scapula** fix and stabilize the scapula and shoulder joint during contraction of the prime movers acting on the humerus .

Muscles around the scapula



4- Synergist: (helper)

- Sometimes the prime mover muscle **crosses many joints** before it reaches its insertion.
- Synergistic muscles will contract to **eliminate the unwanted movements** at the crossed joints. Therefore the action of the prime mover on the desired joint becomes maximal.
- For example, **flexors of fingers** also cross the wrist and to avoid the unwanted flexion of the wrist , the **extensors of the wrist** contract acting as synergists and consequently the flexors of the fingers produce maximum power flexion of fingers only .



⁕ **Clinical Importance:** Muscle atrophy occurs in:

1- Disuse atrophy.

2- Immobilization after fracture.

3- Disease of the muscle itself.

4- Injury of the motor nerve or arterial supply of the muscle.

5- Injury of spinal cord.

6- Affection of higher centers (brain) e.g. hemiplegia,….etc.