Joints II

Factors affecting joint stability (resistance to displacement)

- **Shape of bony structure:**

Shape may refer to the kind of joint, The depth of the cuplike acetabulum of the hip joints gives greater protection against displacement, in contrast to the small size and shallowness of the gleniod fossa of the shoulder joint, is a case in a point.

- **ligaments arrangement:**

-Ligaments are strong, flexible, stress-resistant, somewhat elastic, fibrous tissues that may be in the form of straplike bands or round cords.

-They attach the ends of the bone that form a movable joint and help maintain them in the right relationship to each other.

-They check movement when it reaches its normal limits and they resist movements for which the joint is not constructed e.g. collateral ligaments of the knee.

•Muscular arrangement: they play part in the stability of joints specially in joints whose bony structure contribute little to stability e.g. rotator cuff of the shoulder. The shoulder joint is a notable example, getting its greatest strength from the shoulder and arm muscles that cross it. Of the six muscles that act on the shoulder joint, four of them, known as the **rotator cuff (subscapularis, supraspinatus, infraspinatus, and teres minor) are particularly important as stabilizers of this joint.**

•Fascia: according to location & function of the fascia, it may vary from thin membranes to tough fibrous tissue.

•Atmospheric pressure: this plays a role mainly in the hip joint.

Factors affecting range of motion

•**Shape of articular surfaces:**

Joints with more congruent articulations tend to restrain motion and are more stable, while those having less congruent surfaces typically allow more mobility.

•**Restraining effect of the ligaments & muscles crossing the joint as well as overlying skin:**

Ligaments exhibit unique designs to provide stabilization without limiting too much motion.

•**Controlling & restraining action of the muscles:**

•e.g. hamestring muscle tightness when attempting to touch the floor as an antagonist for hip flexion.

- **Body build:** (mesomorph & the ectomorph usually have greater flexibility than endomorph).

- **The bulk of tissue in the adjacent segments** e.g. protruded abdomen limit the action of touching the chest with flexed hip and knee.

- **Personal exercise habits,** where training certain group for flexibility may increase the range while training for strength may limit the range.

- **Current state of physical fitness.**

- **Age.**

- **Heredity.**

N.B. apparent ROM can be affected by the close relationship exist between certain joints. E.g. relationship of pelvic tilting to movement of the hip.

ROM can be affected by the method the joint is moved whether actively by internal force or passively by an external force.

Beside the previous factors:

- Apparent range of motion can be affected by the close relationship that exists between certain joints.
- Relationship of pelvic tilting to movement of the hip and the relationship of shoulder girdle articulation to movement of the shoulder joint.
- Range of motion can be affected by the method the joint is moved with whether actively by an internal force or passively by an external force.


Body link system &
kinematic chain

•**Body link system:**

A body link is the central straight link which extend between 2 joint axes of rotation.

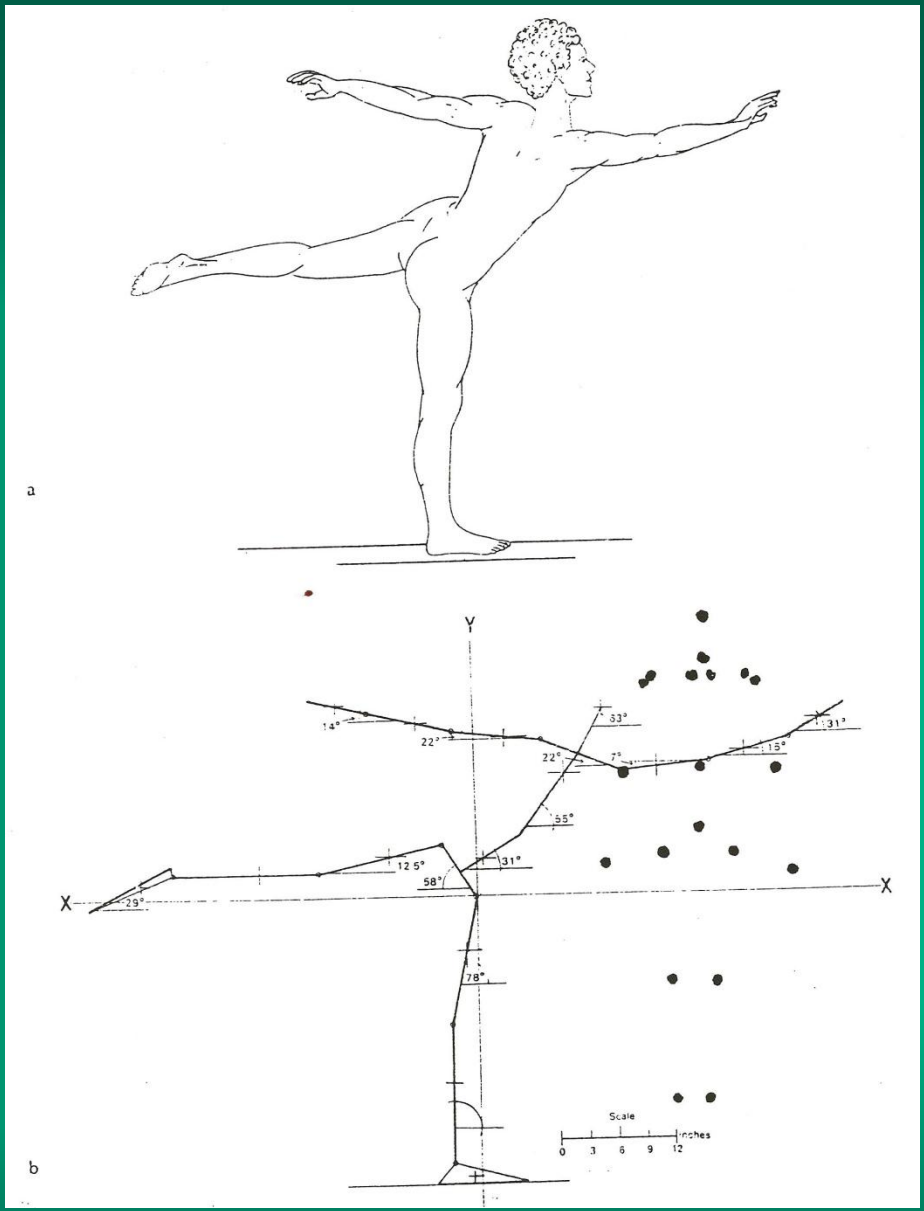
- **in case of hands & feet, the terminal links are considered to extend from the wrist & ankle joint centers to the center of mass of these so called members.**

- Link systems are interconnected by joints which predetermine the particular type of motion permitted to the functional segments.

- The link system is used to make calculations regarding different body segments in different positions.

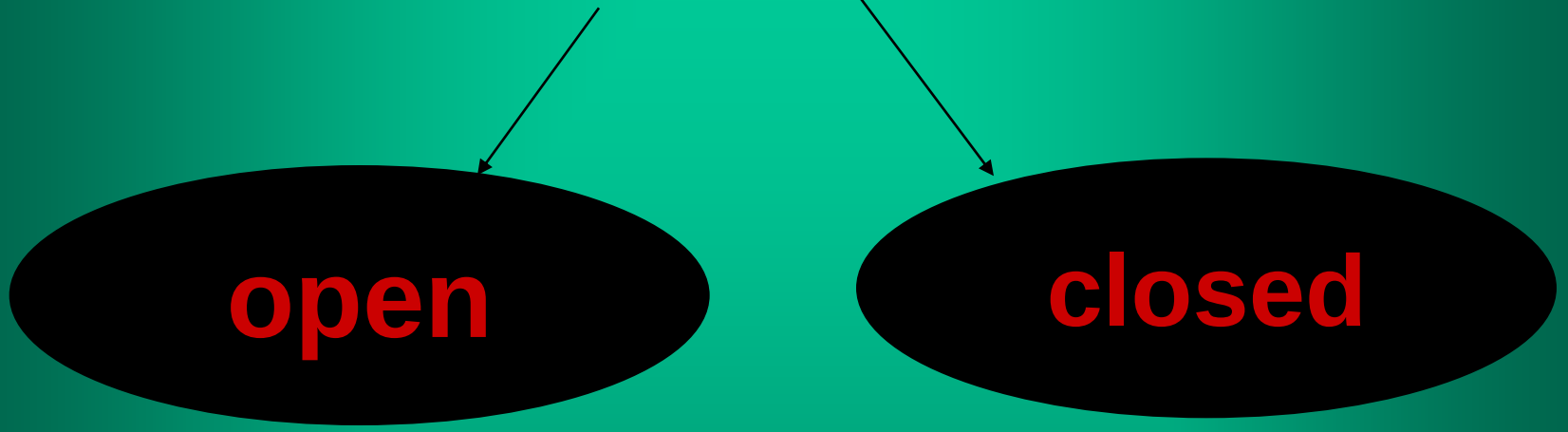
•Kinematic chain

- It is a combination of several successively arranged joints constituting a complex motor system.
- In other words, when a number of links are united in series, they form what is called kinematic chain.
- The kinematic chain may be *open* or *closed*.



Link & kinematic chain

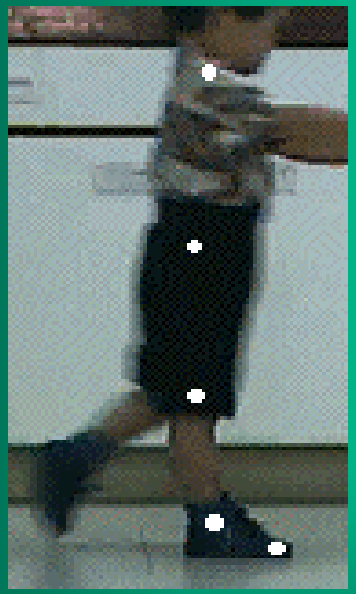
Kinematic chain



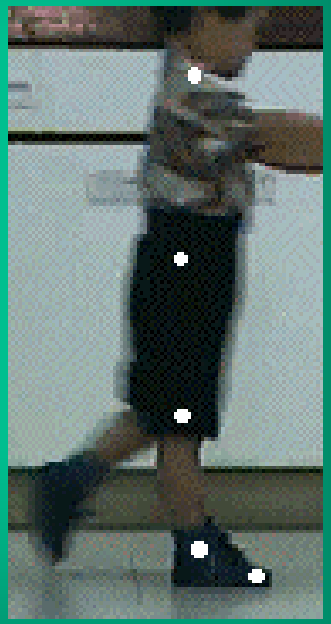
-The distal and terminate free in space.
-It has a characteristic degrees of freedom.
-The distal segments posses higher degrees of freedom than the proximal one.
-Such linkage system allows the degrees of freedom of the many joints in the chain to be pooled giving the segments greater potential for achieving a variety of movements than can any one joint could possibly have on its own.

-The distal segment is fixed and
- The terminal joint meets with great resistance which restrain its free motion e.g. chinning oneself on horizontal bat or stance phase of gait cycle.
- End segments are united to form a ring when one link moves, the other links will move in a predictable pattern e.g rib cage

- N.B. walking, ascending& descending stairs are examples of alternation between open & closed chains.
- Open kinematic chains are the most common type in the human body.



reference limb is **off the ground** (open kinematic chain)



reference limb is **on the ground** (closed kinematic chain)

Use of body link and kinematic chain concept:

A link diagram can be drawn of the body in various positions using these diagrams, calculations are made which provide a more detailed description of the position than can be obtained from simple observational method alone.

- By adding the degrees of the joints in an open chain such as the upper limb, the degrees of freedom at each segment can be determined. The more distal the segment, the greater the degrees of freedom it possess. For example, each of the distal phalanges in the hand has 17 degrees of freedom relative to the trunk and 11 degrees of freedom relative to glenohumeral joint.

- When many degrees of freedom of many joints in the chain are poled together, the segments particularly those lies more distal, have greater potential for achieving a verity of movements than any one joint could possibly have on its own

- When a joint in the chain become restricted, the versality of the distal segments will be reduced by a factor which is equivalent to the number of degrees of freedom lost.


Characteristics of different Synovial joints
Lab activities and SL

Hip joint

- Is a ball & socket joint with a marked degrees of interlocking which lead to limited ROM partially compensated for by movement of the lumbar vertebrae but is distinctly more stable.

- These features of the hip joint derive from the basic functions of lower limb support of body weight & locomotion.

- It has 3 degrees of freedom.

ROM

- **Flexion**: it varies according to:

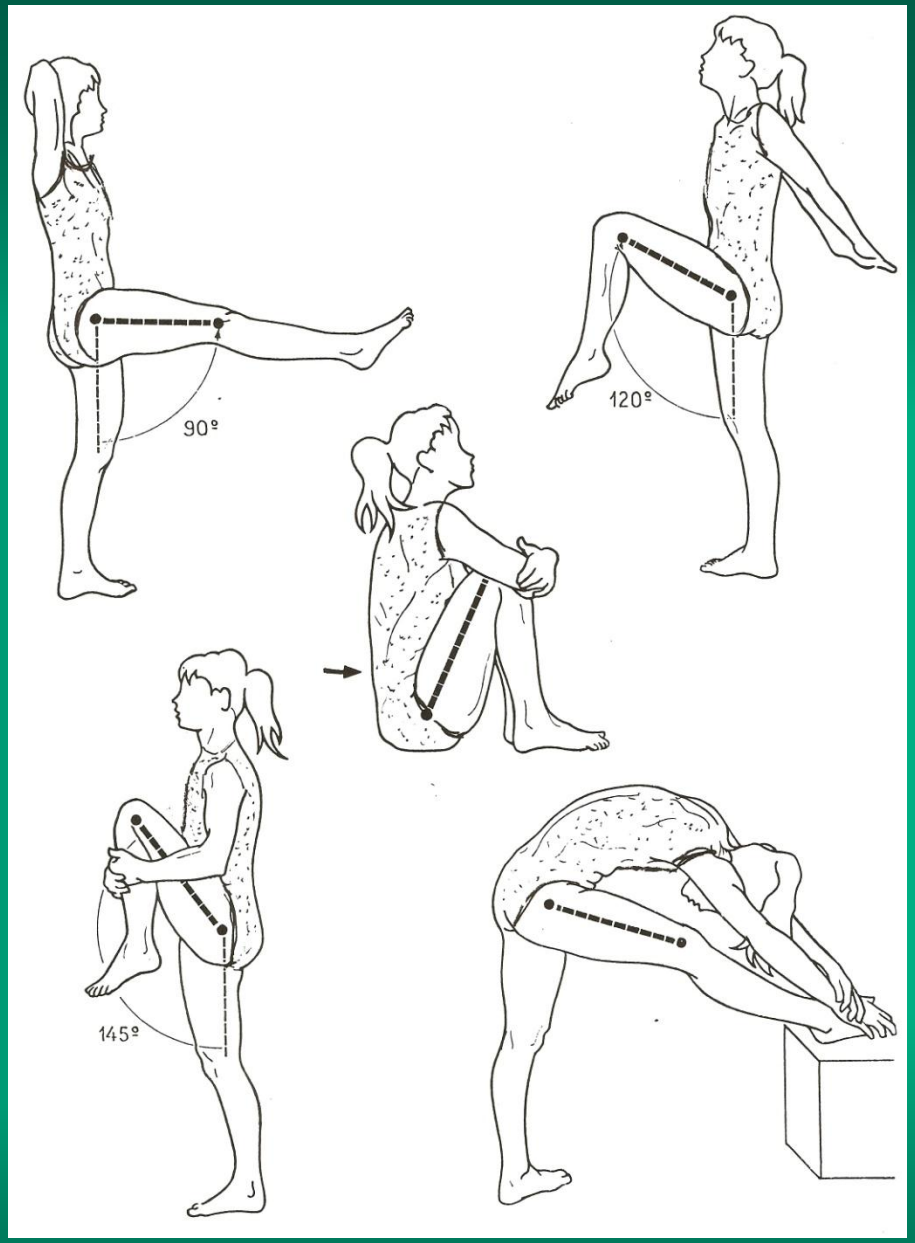
  -Whether the range is passively or actively achieved.

  -Whether the knee is flexed or extended.

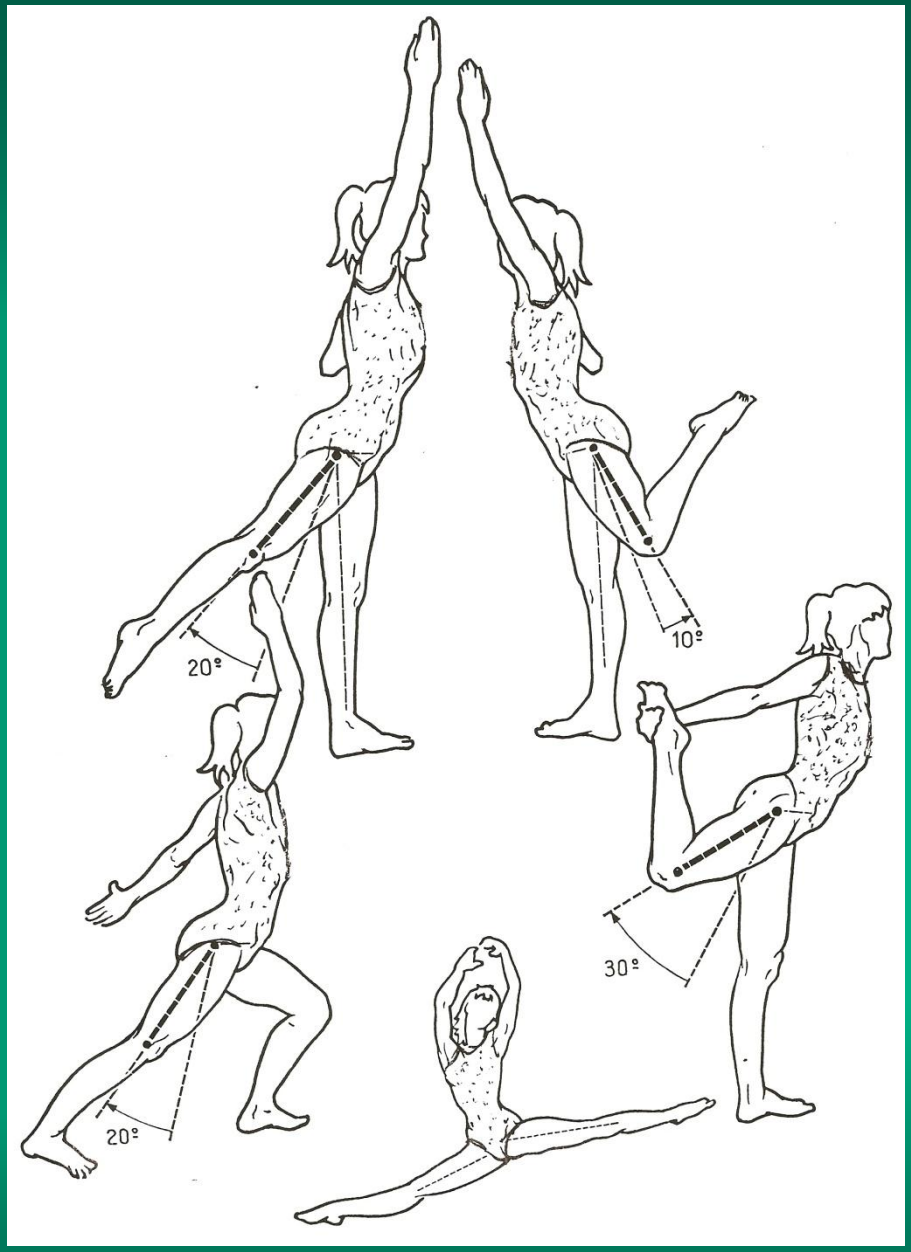
- **Extension**:

  -Is limited by iliofemoral ligament, also is affected by whether the knee is flexed or extended, and whether actively or passively performed.

  -Range of hip extension is increased by anterior tilting of the pelvis due to exaggeration of lumber lordosis.



Active and passive range of hip flexion with extended and flexed knee.

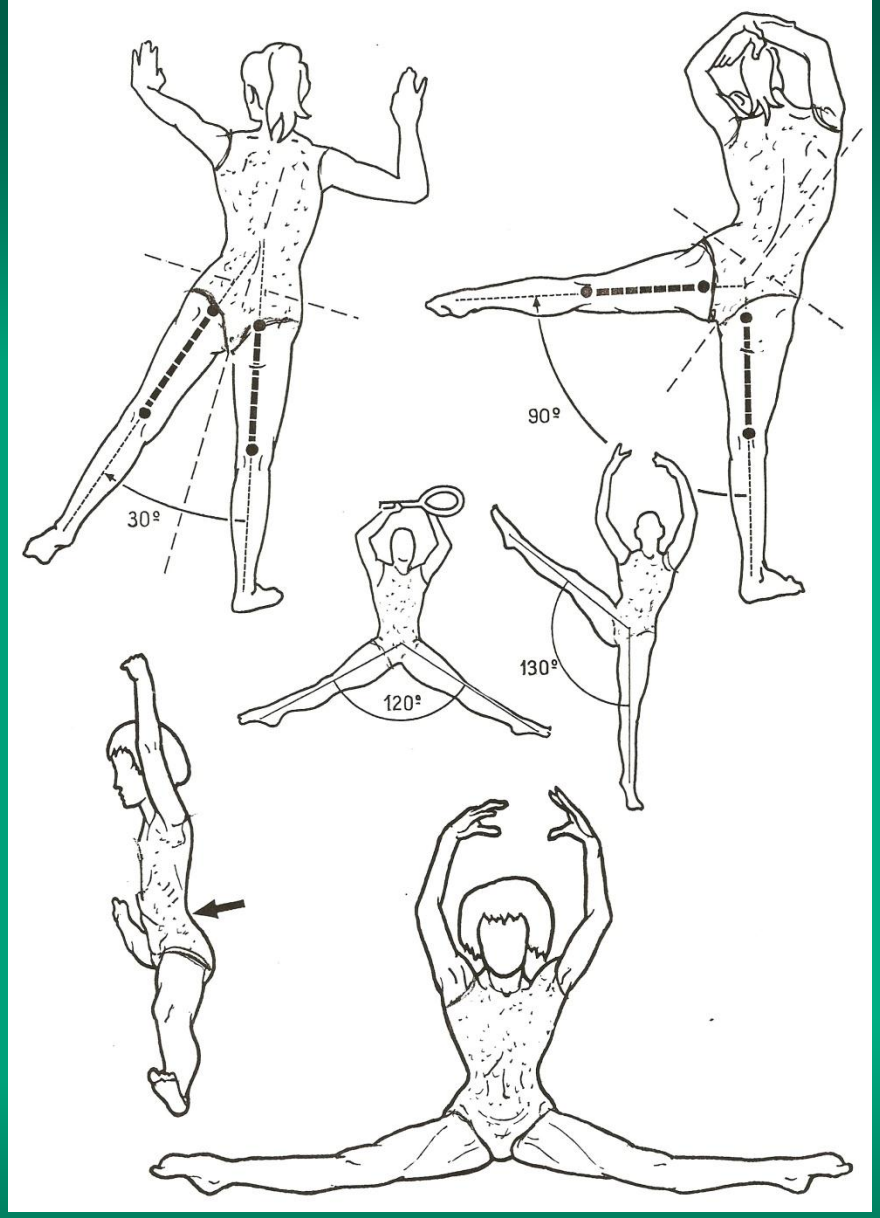


Active and passive range of hip extension with flexed and extended knee.

- **<u>Abduction</u>:**

  -Theoretically abduction can occur at one hip, in practice abduction of one joint is automatically followed by a similar degree of abduction at the other joint. this is obvious after 30 ° abduction.

  -When abduction reach a maximum, the angle between the two L.L. is a right angle, so that each limb has a maximum of 45 °.



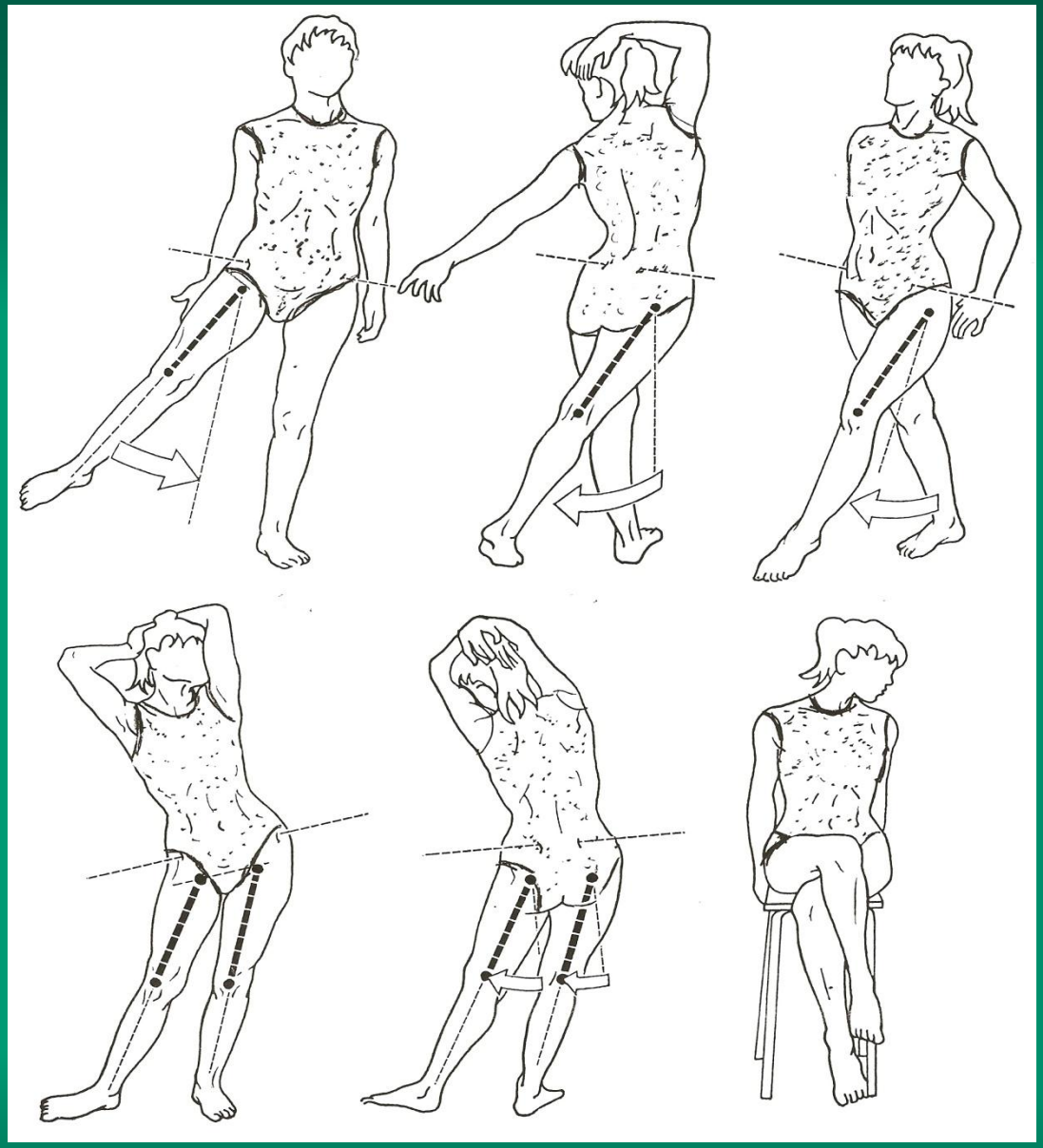
Active and passive range of hip abduction.

- Adduction:

1. There no pure adduction from the anatomical position, but relative adduction occurs as when the limb moves medially from any position.

2. Adduction can be combined with flexion, extension of the same limb, or abduction of the other limb.

3. The maximum adduction is 30°

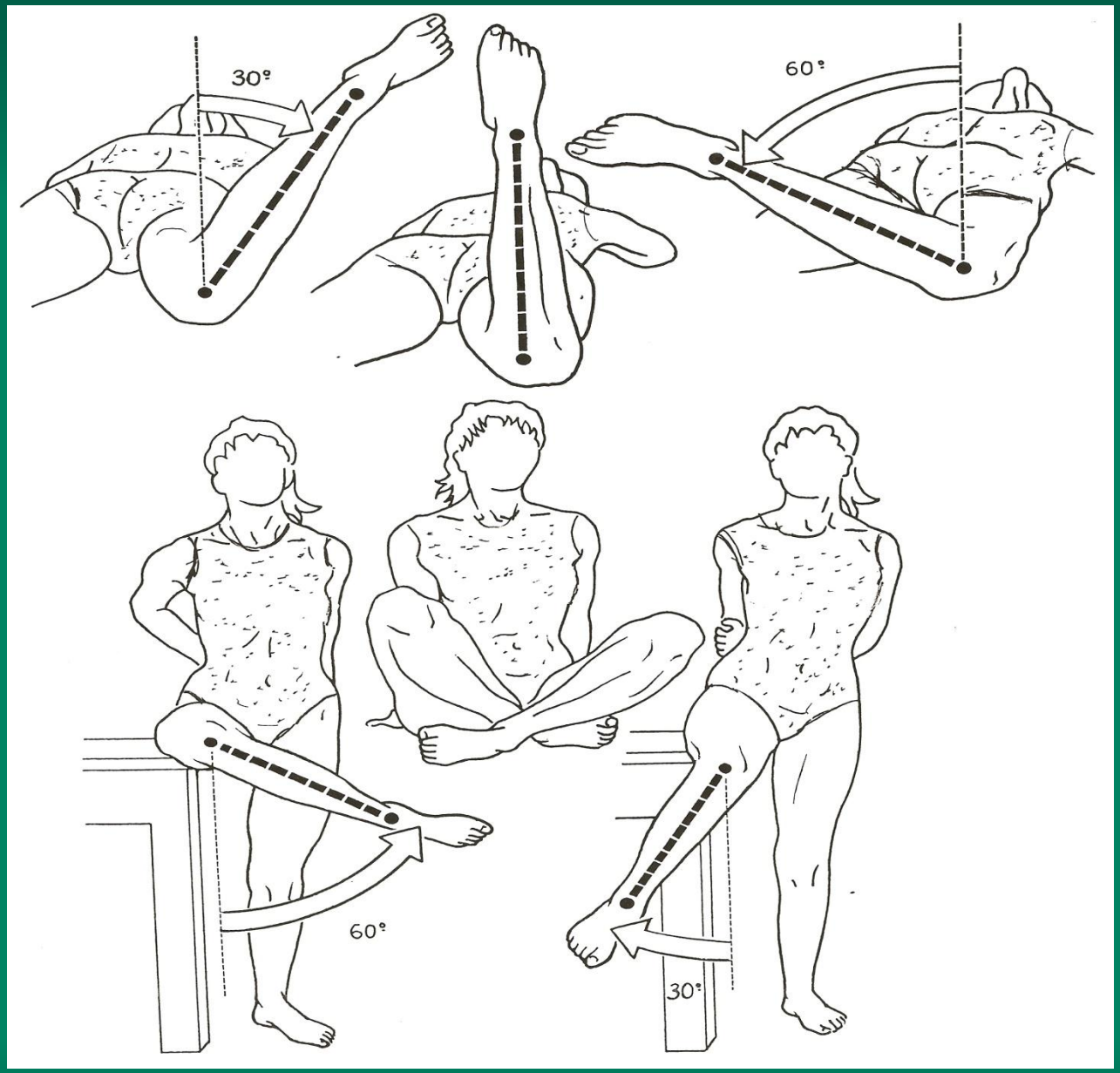


Active and passive range of adduction.

- Rotation:

1. Medial rotation of the hip joint 30-40°
2. Lateral rotation up to 60°

- N.B. when the hip & knee are flexed to 90°, the total range of external rotation increase because hip flexion relaxes the iliofemoral & pubofemoral ligaments. The range of rotation depends on the angle of anteversion of the femoral neck.



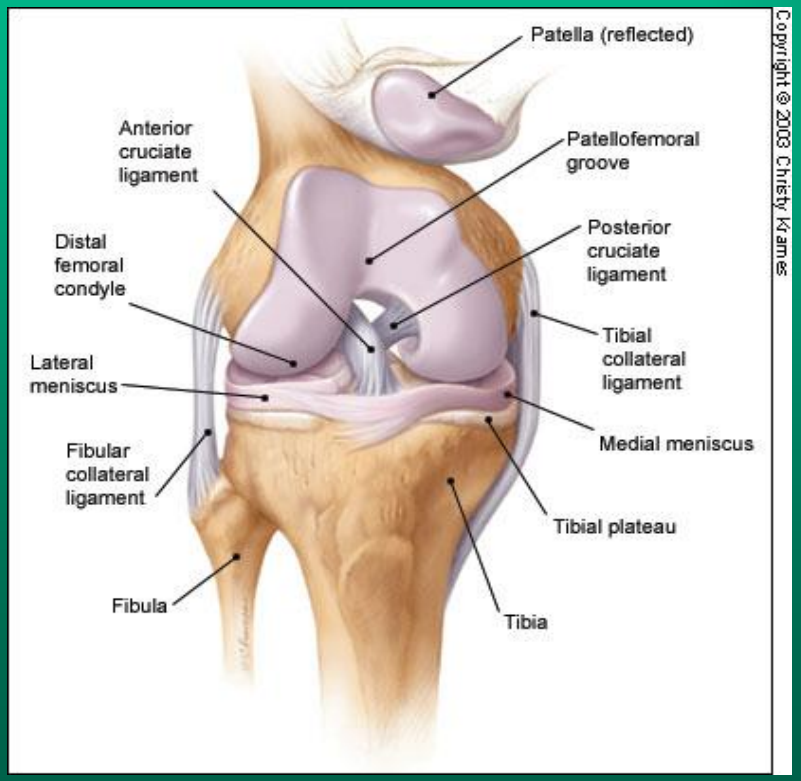
Active and passive range of rotation.

- Circumduction:

- It is a combination of the elementary movements occurring simultaneously around the 3 axes.

Knee joint

- It has mainly one degree of freedom, and an accessory degree of freedom which allow rotation of the long axis of the leg only when the knee is flexed.



- Physiological valgus of the knee occur because the axis of the femoral shaft doesn’t coincide with that of the leg but forms with the latter an obtuse angle of 170-175 opening outwards.

ROM

- Extension: relative extension
- Flexion: absolute & relative

N.B. range of flexion varies according to:

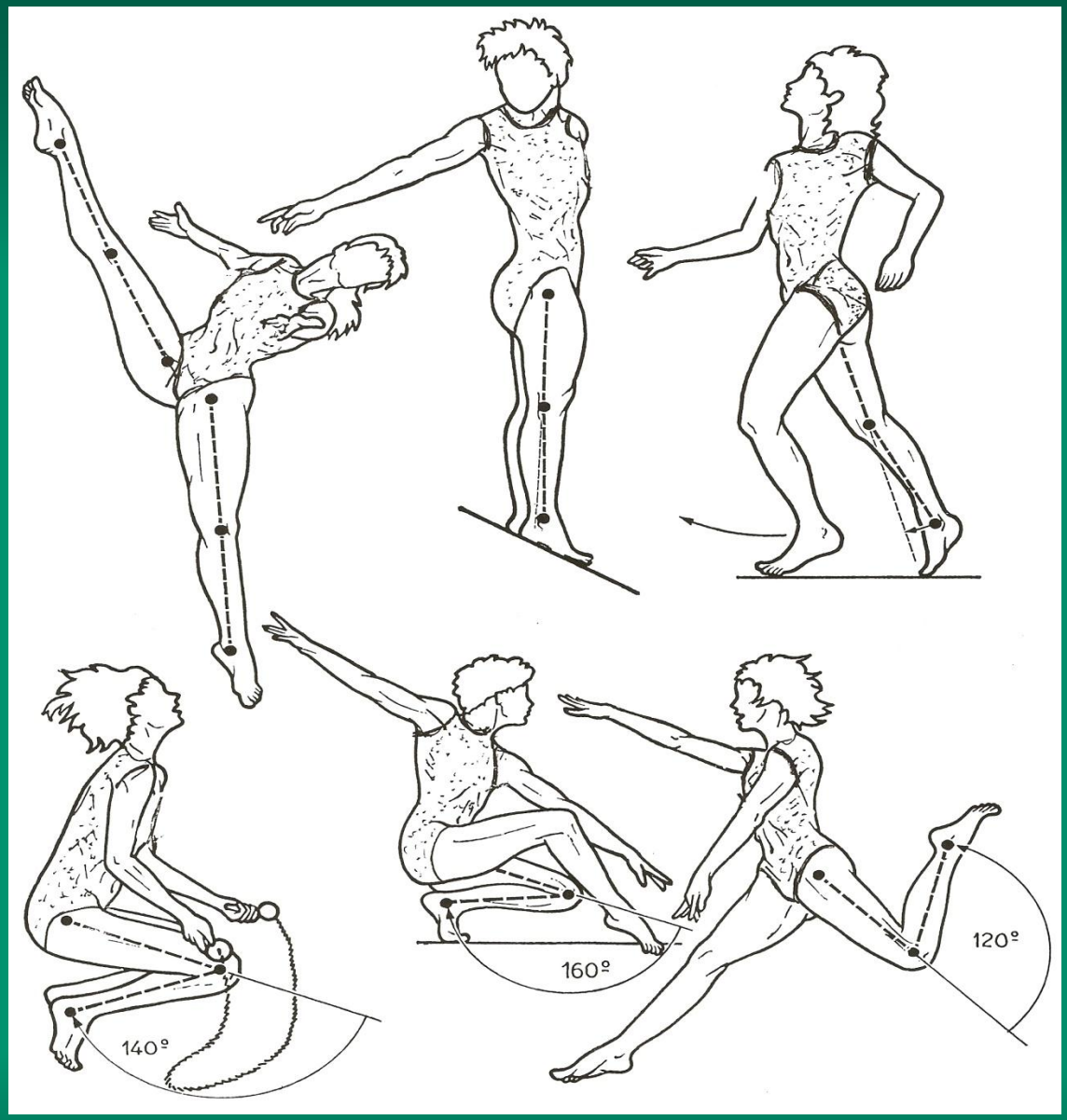
- position of the hip
- Whether it is active or passive range.
- Active flexion with hip already flexed: 140 °
- Active flexion with hip extended: 120 °
- Passive flexion: 160 °

- Axial rotation:

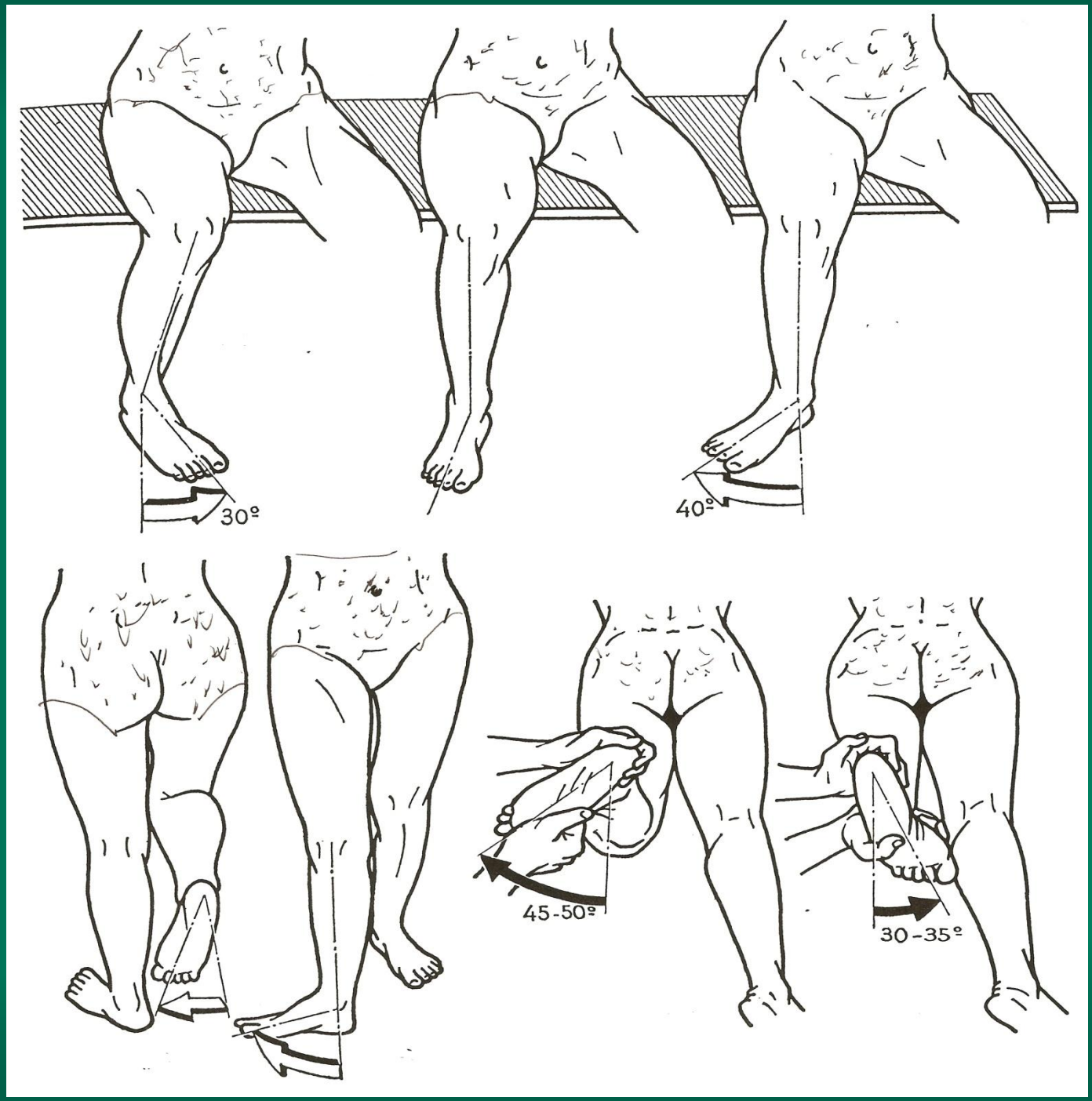
➢ Medial rotation:40 °

➢ Lateral rotation 30 °

➢ Automatic rotation occur at the end of extension (lateral), &at beginning of flexion (medial).



Active and passive range of knee flexion and extension

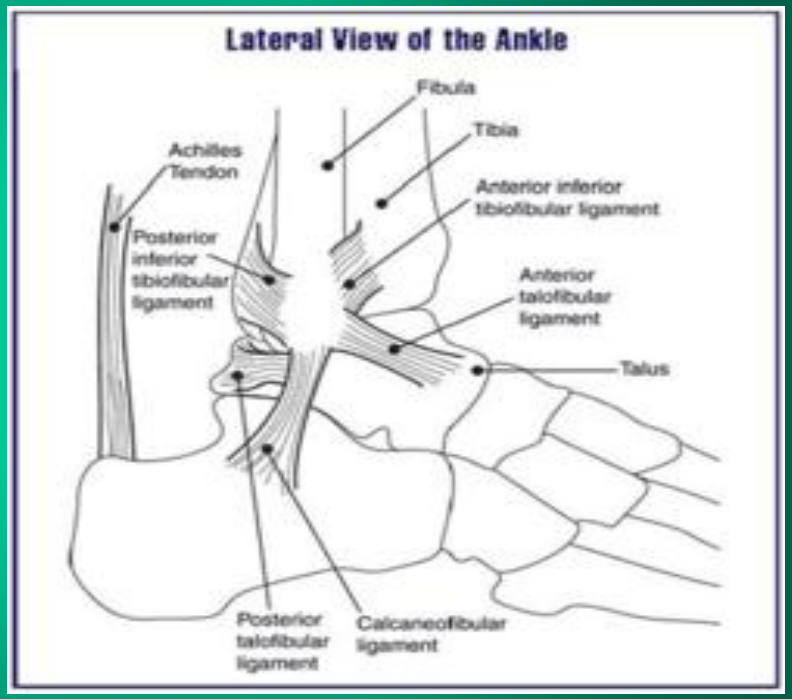

30º
40º
45-50º
30-35º

Ankle joint

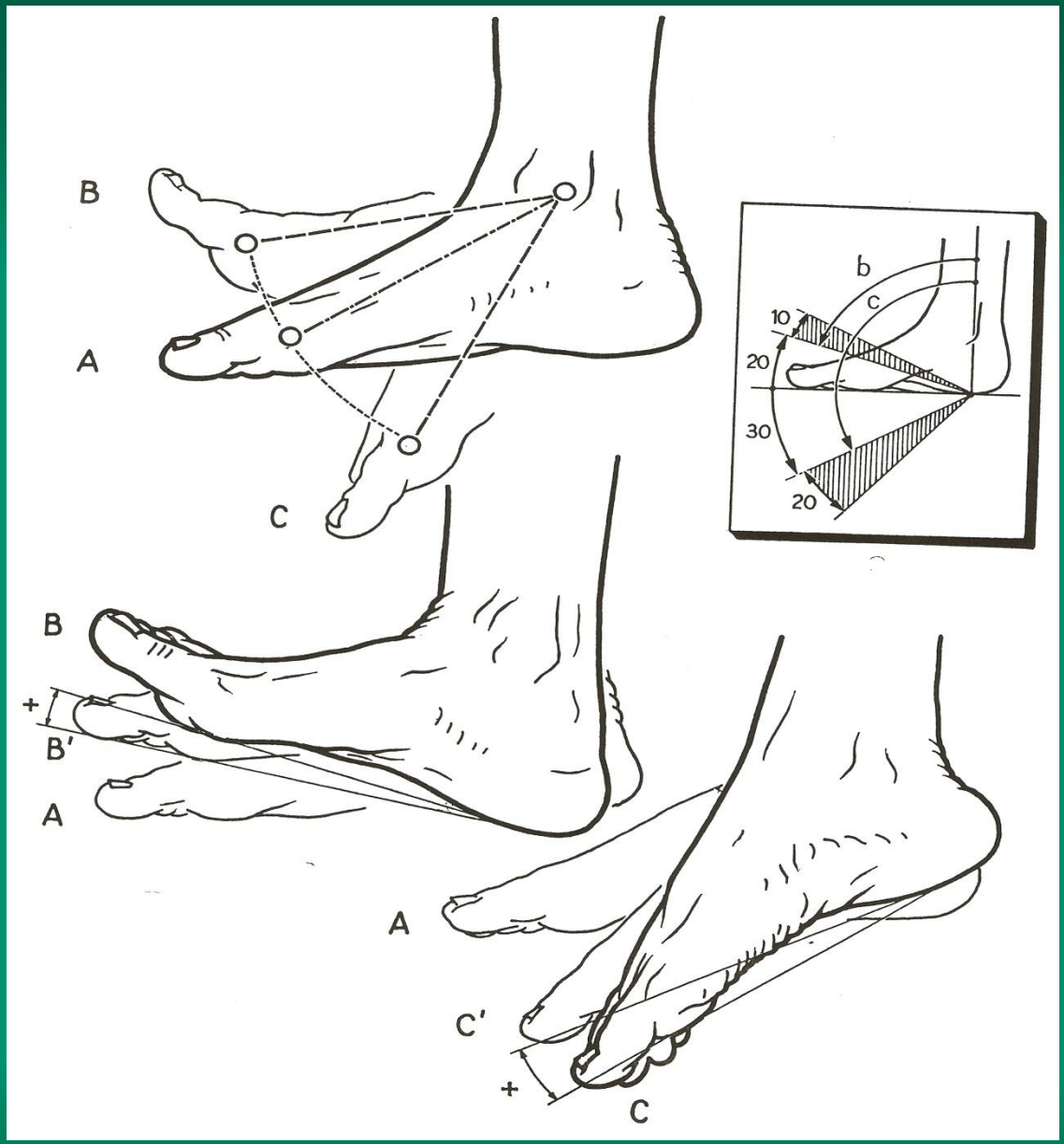
- Has one degree of freedom, & allow planter flexion, and dorsiflexion.
- Dorsiflexion (flexion): 20-30°
- Planterflexion (extension): 30-50°

N.B.Flattening, and hollowing of the planter arches lead to increase of these movements.


Fibula
Tibia
Anterior talofibular ligament (partial tear)
Calcaneofibular ligament (stretched)


Lateral View of the Ankle
Fibula
Tibia
Achilles Tendon
Anterior inferior tibiofibular ligament
Posterior inferior tibiofibular ligament
Anterior talofibular ligament
Talus
Posterior talofibular ligament
Calcaneofibular ligament

Ankle joint



Range of motion of Ankel joint.

The Shoulder girdle

- It is composed of 5 joints falls into 2 groups:
- Group I:

1. Glenohumeral joint (true anatomical joint)
2. Subdeltoid joint (false physiological joint)

- Group II:

3. Scapulothoracic joint (false physiological joint & is the most important in this group)

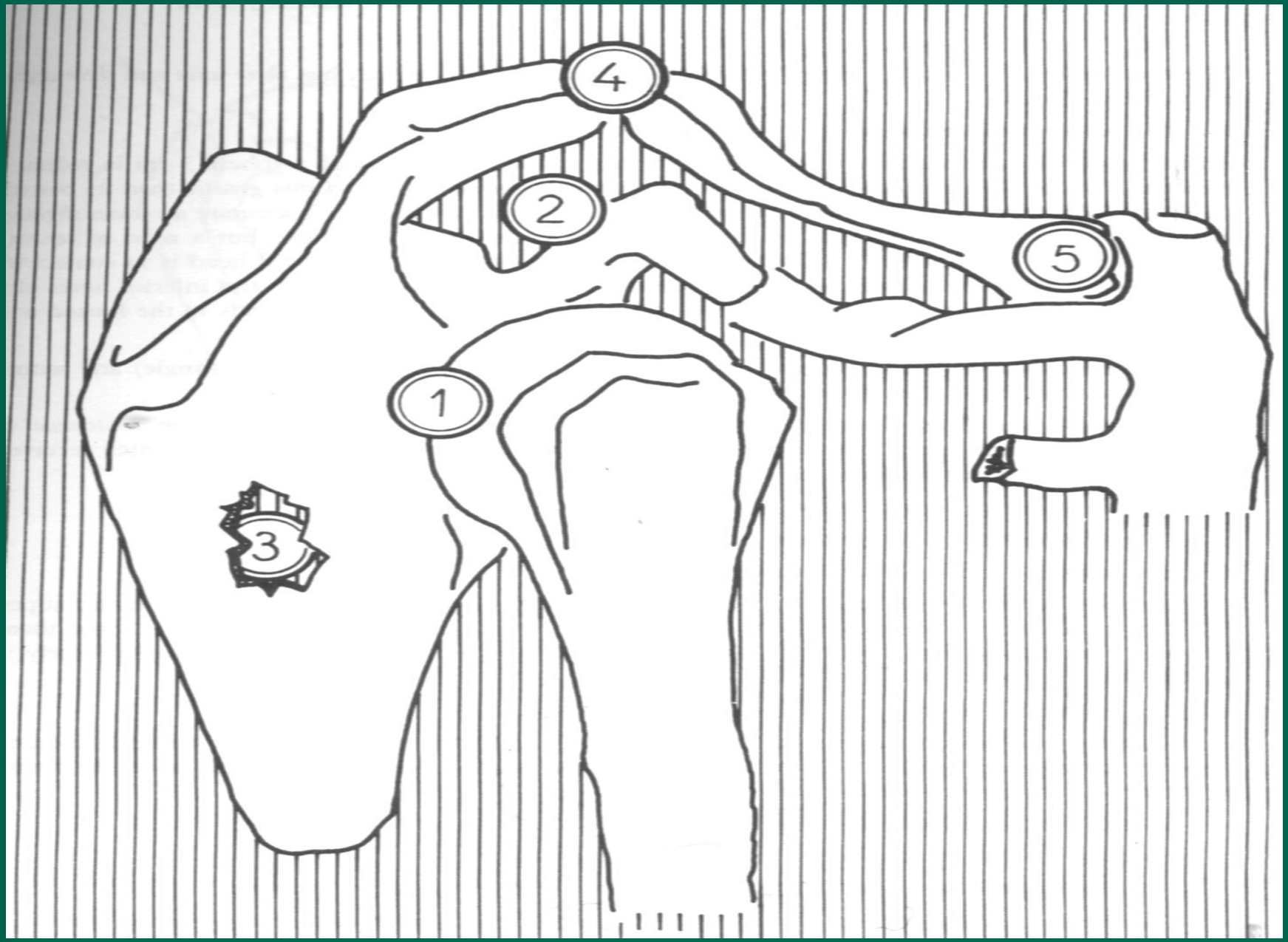


Fig. Joints of the shoulder girdle

Scapulothoracic articulation is composed of:

- The space between the scapula & serratus anterior.
- The space between the thoracic wall, & the serratus anterior muscle.

4. Acromio clavicular joint (true anatomical joint)
5. Sternoclavicular joint (true anatomical joint)

- N.B. in each group, the joints are mechanically linked i.e. they must function in concert. Both groups also work simultaneously with a variable contribution from each set depending on the type of movement.

The shoulder joint

- Is the most mobile of all the joints in the human body.
- It has 3 degrees of freedom:
- Flexion up to 180
- Extension up to 45-50
- Abduction up to 180

Shoulder joint.

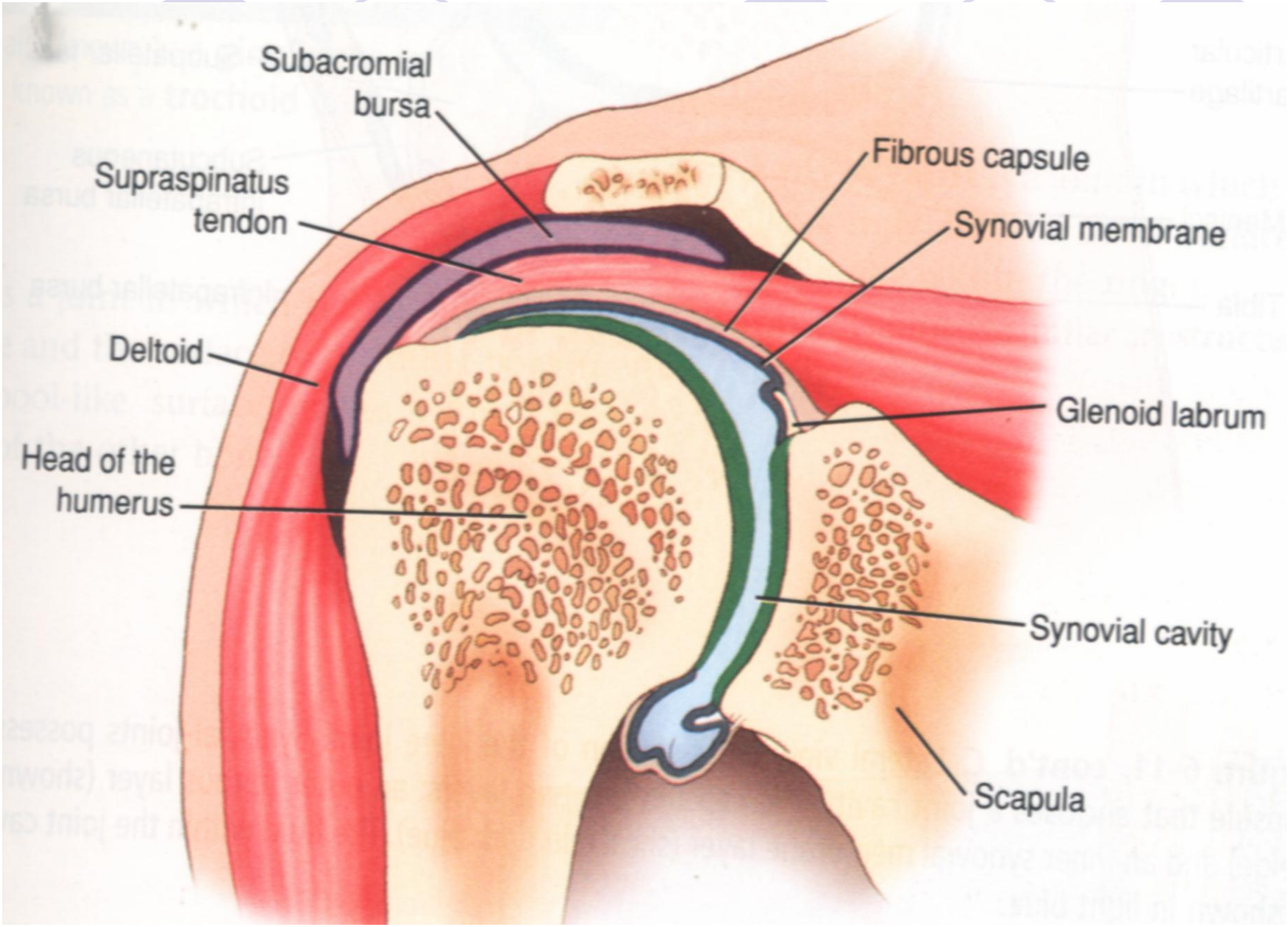


Fig. Shoulder region

- Adduction:

  no absolute adduction because of presence of the trunk & is only possible when combined with:

- extension (allow trace of add.)
- Flexion (adduction can reach 30-45

relative adduction starting from any position of abduction.

- Rotation:
- *Medial rotation:*

  Up to 100-110 with elbow flexed up to 90 with the forearm passing behind the trunk & the shoulder slightly extended.
- *Lateral rotation:*

  Up to 80 with the elbow flexed & arm beside the body.

- Horizontal flexion: 140
- Horizontal extension: 30-40

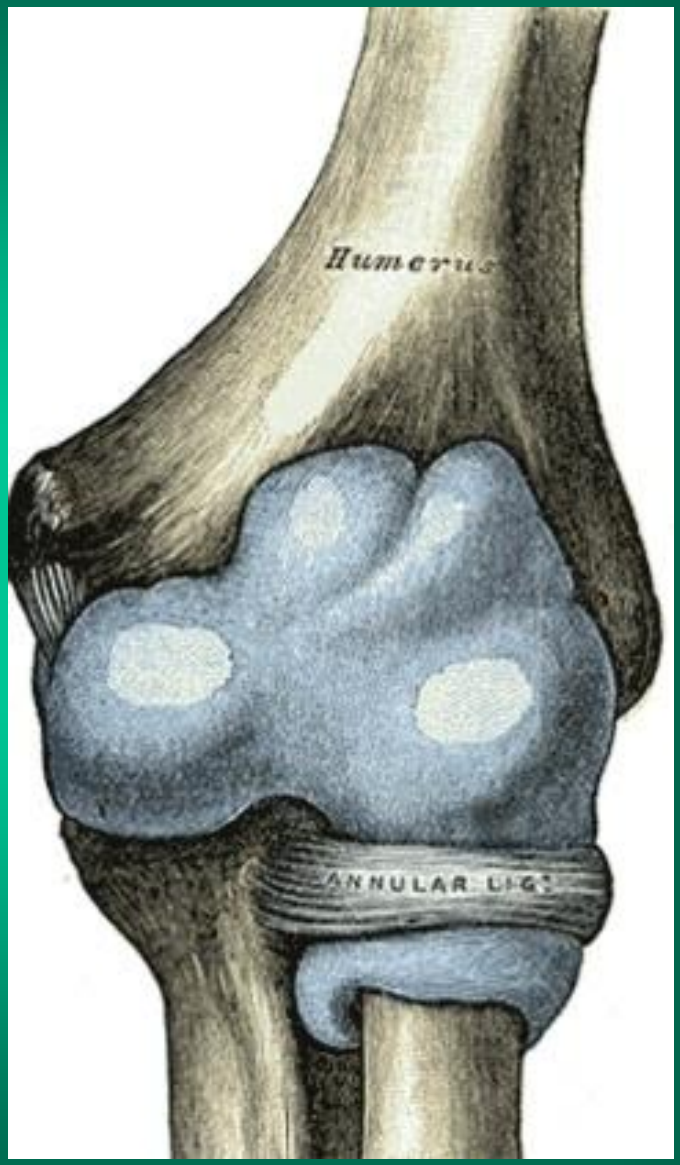
  N.B. the reference position is 90 abduction of the shoulder.
- Close packed position: maximal abduction & external rotation.

Elbow joint

- Is a hinge joint with one degree of freedom
- Elbow flexion: active 145 & passive 160
- Elbow extension:

➢ *Normal extension* is zero degrees. The axis of the arm & forearm are in straight line.

➢ *Relative extension* when the elbow is extended from any position of flexion.



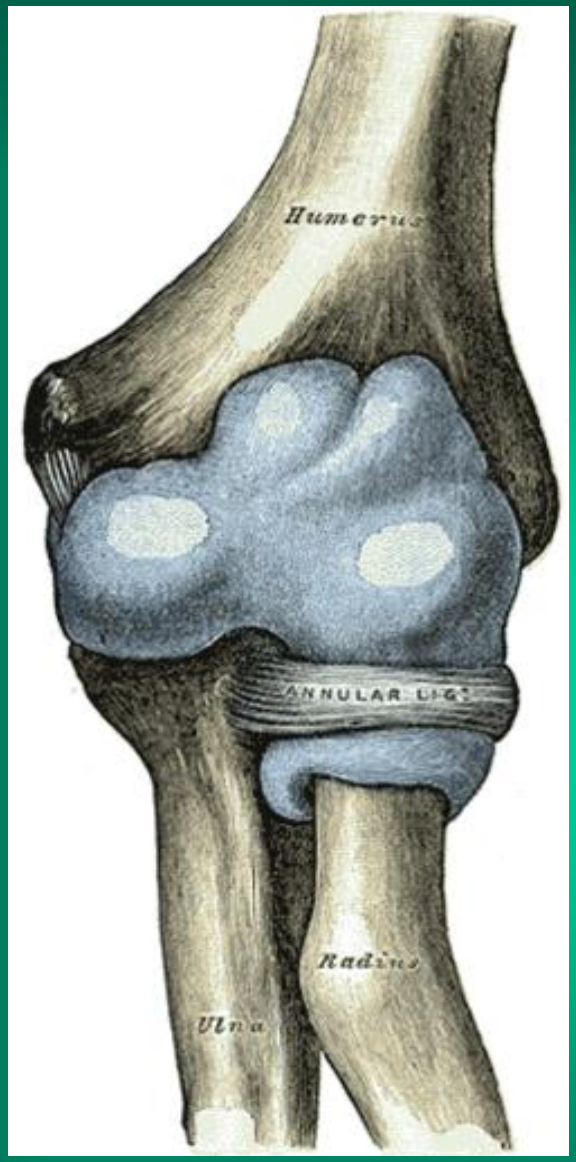
Elbow joint.

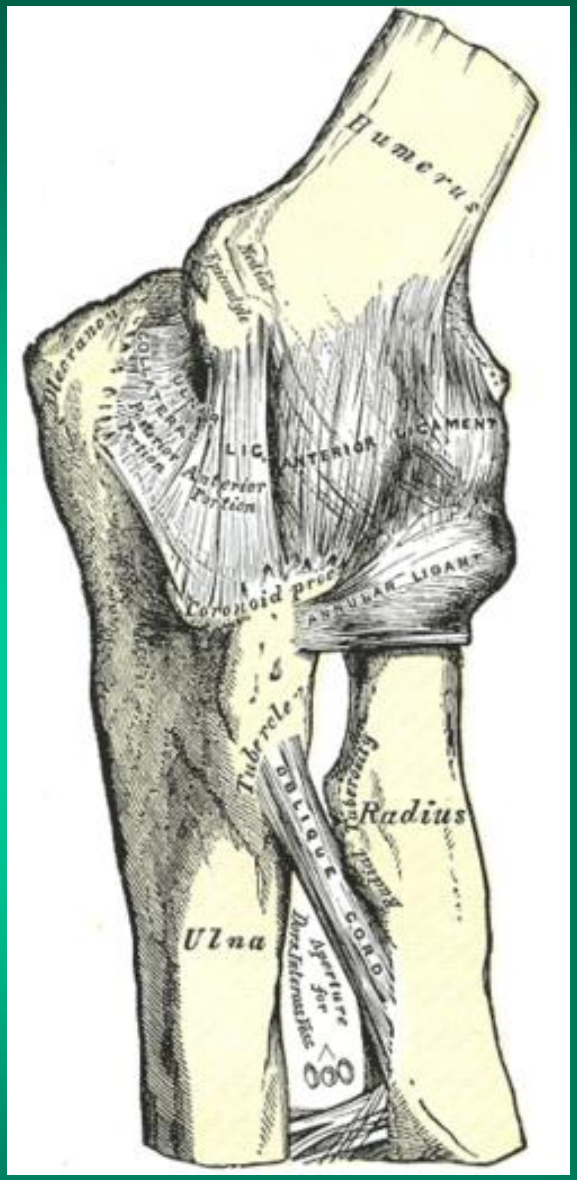
Radioulnar joint

- It is a pivot joint with one degree of freedom.
- It involves 2 joints which are mechanically linked.
- The superior radioulnar joint which anatomically belongs to the elbow joint.
- The inferior radioulnar joint which is anatomically separate from the wrist joint.

- The reference position for its movements is elbow flexion with forearm is in midway and the thumb facing upward.

- If the elbow is extended, the forearm is in line with the arm and axial rotation of the forearm is compounded with that of the later owing to rotation of the shoulder.



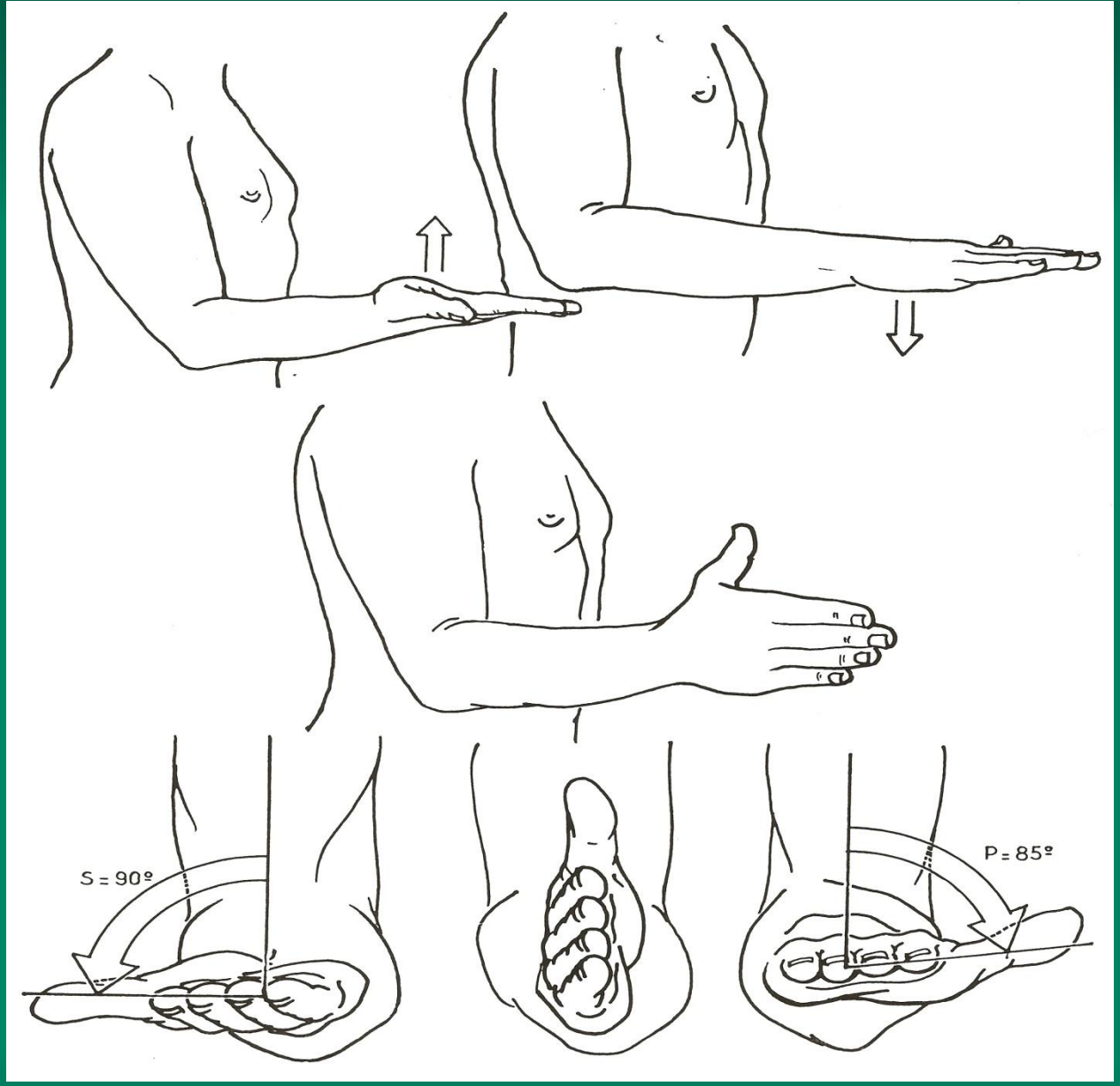


Radioulnar joint.

ROM

- Supination: 90°
- pronation: 85° (because of the orientation of the radius.

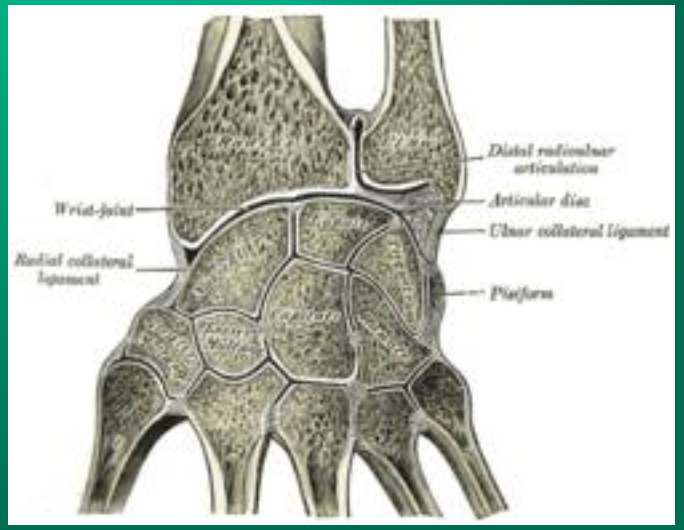
  N.B. Pronation, and supination are very important for the control of hand orientation.
- Closed packed position: 5° supination.



Range of motion of radioulnar joint.

Wrist joint

- It is an ellipsoid joint with two degrees of freedom.



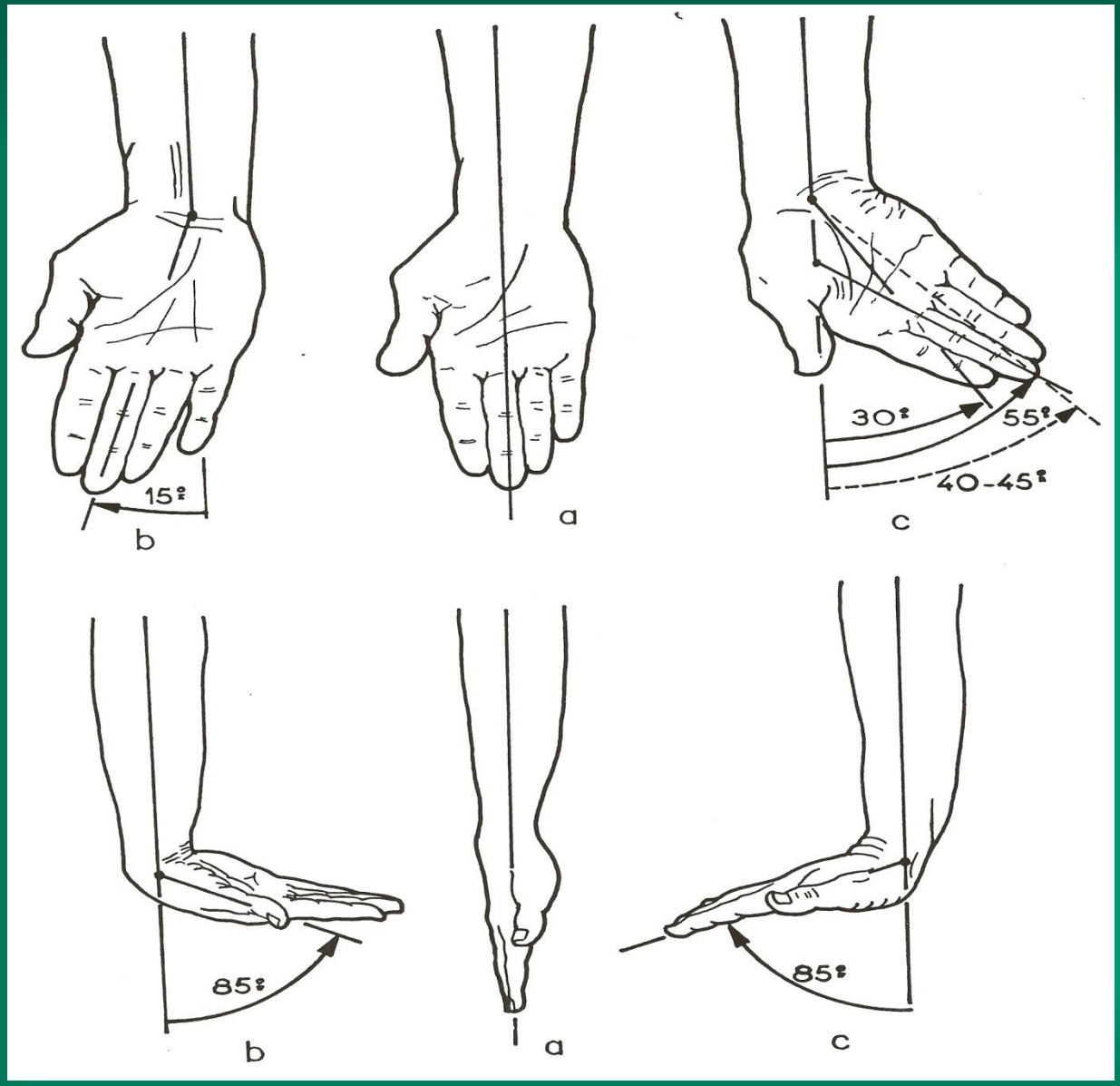
ROM

- It allows the following movements from the anatomical position:
- Flexion: 85°
- Extension: 85°

N.B. this range is minimally changed when the radioulnar joint is in pronation.

- Abduction: 15°
- Adduction: 45°

N.B. this range is minimal when the wrist is fully flexed or extended because of the tension developed in the carpal ligaments.



Range of movement of wriste joint.

- Circumduction:

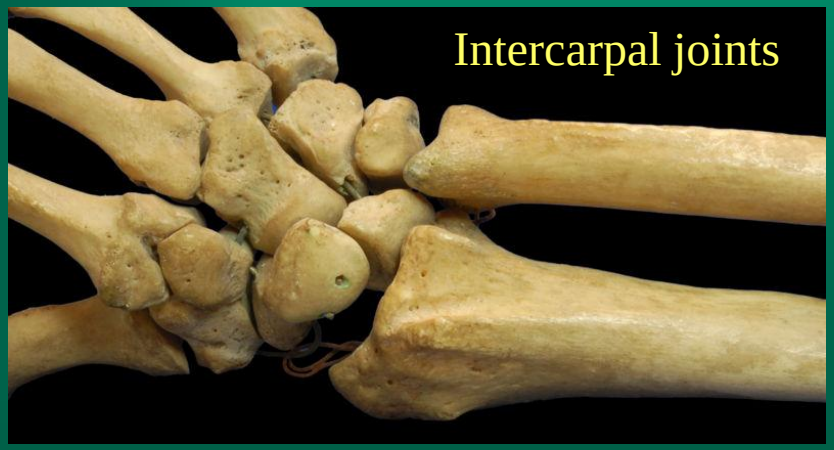
  Is the combination of the movement of flexion, extension, adduction, and abduction.

  N.B. the midcarpal joint which lies between the two rows of carpal bones is mechanically connected to the wrist joint & together form the articular complex of the wrist.

- Closed packed position: maximal extension with maximal ulnar deviation.

Nonaxial synovial joints

- A nonaxial joint allows motion to occur within a plane, but this motion does not occur around an axis.
- The motion that occurs at a non axial joint is a gliding movement in which the surface of one bone merely translate.
- E.g., intercarpal joints and facet joints of the spine.




Thank you