Arthrology

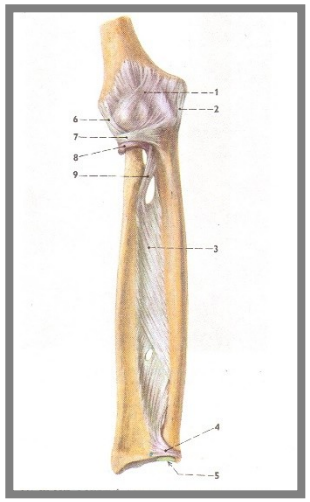
arthros *(joint)*, logos *(science)*

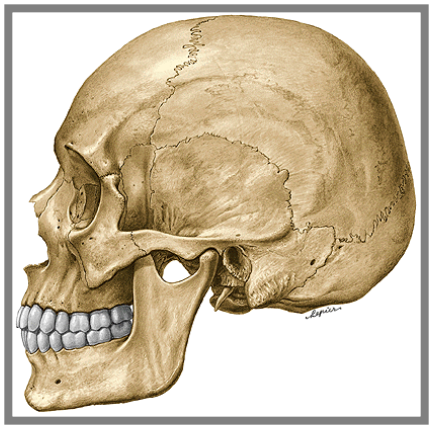
articulatio = *joint*

Arthrology – study of joints (articulatio)

1) Synarthrosis *(continuous/fibrous joint)* – <u>continuous</u> connection of bones by connective tissue (fibrous tissue, cartilage, bone)

2) Diarthrosis *(discontinuous/synovial joint)* – <u>movable</u> connection of bones by contact of articular surfaces covered by articular cartilage and with
additional features





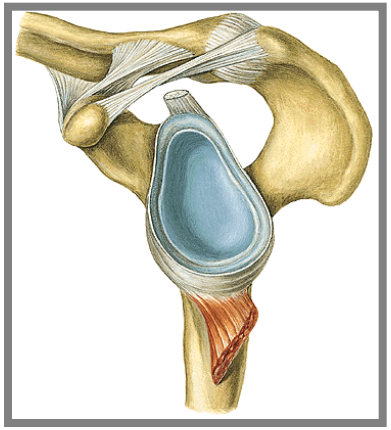
Synarthrosis = continuous/fibrous joint

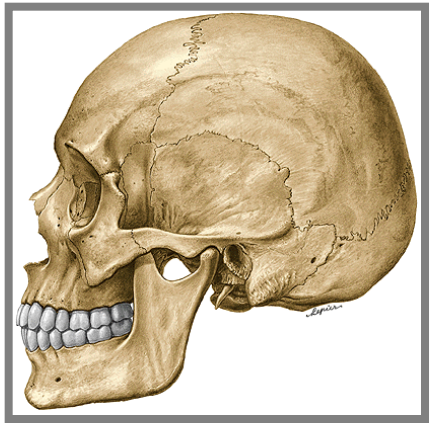
(nearly immobile, continuous articulation of bones)

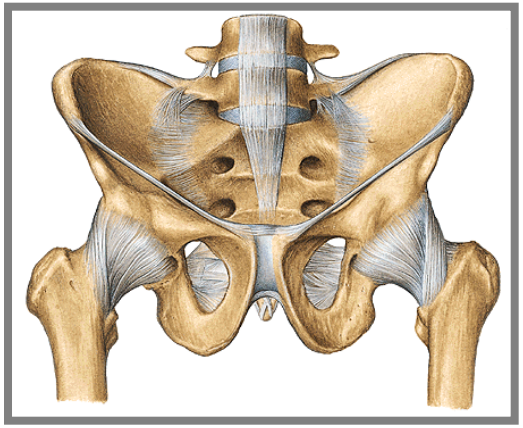
1) Syndesmosis *(fibrous joint)* – bones are linked by connective tissue (colagenous or elastic) – *ligaments*, *gomphosis* (peg-and-socked joint) and sutures

2) Synchondrosis *(cartilaginous joint)* – bones are linked by cartilage

3) Synostosis – bones are linked by bone tissue







I. Synarthrosis *(continuous/fibrous joint)*

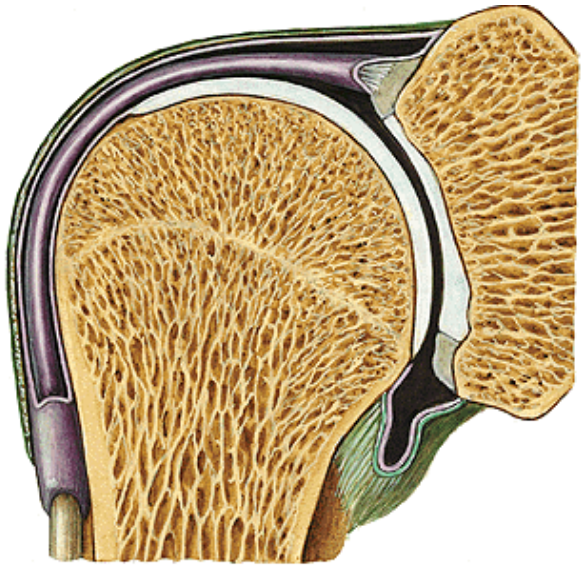
1. syndesmosis

2. synchondrosis

3. synostosis

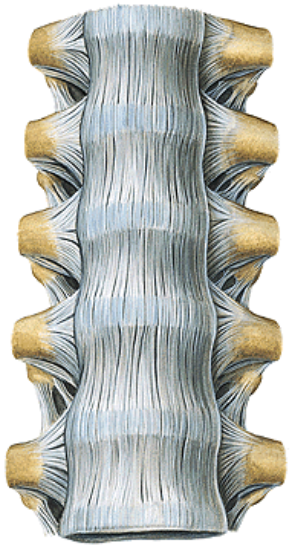
II. Diarthrosis

= articulatio = *(synovial joint)*



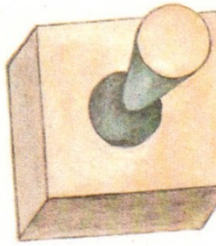
Ad 1. Syndesmosis *(fibrous joint)*

1. Ligaments



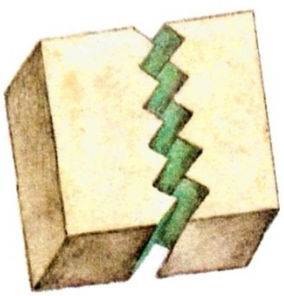
2. Membranes

3. Gomphosis
(peg-and-socked joint)



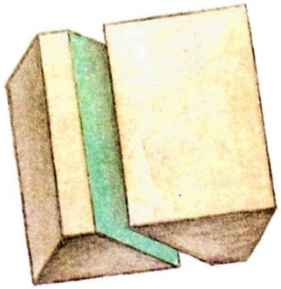
4. Sutures

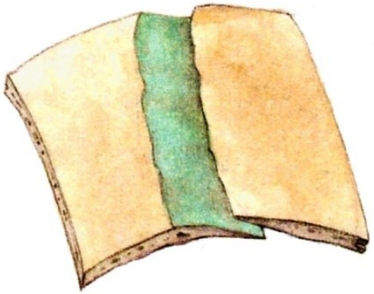
4. Sutures



Sutura serrata

(with saw-like edges)

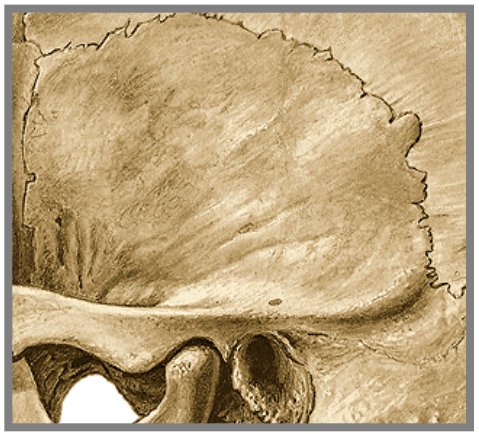


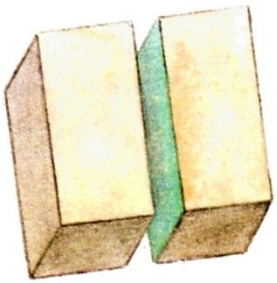


Sutura squamosa

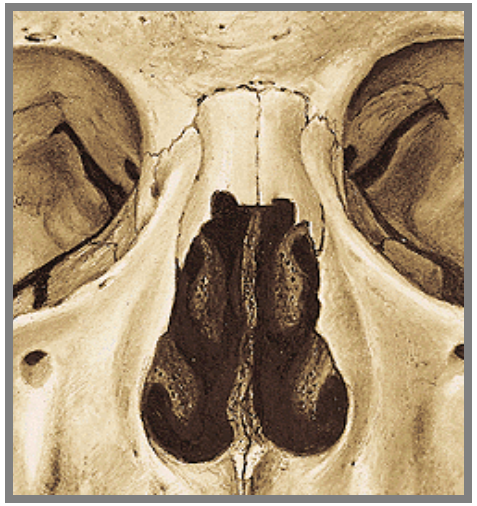
(Squamous suture)

One bone overlaps another





Sutura plana

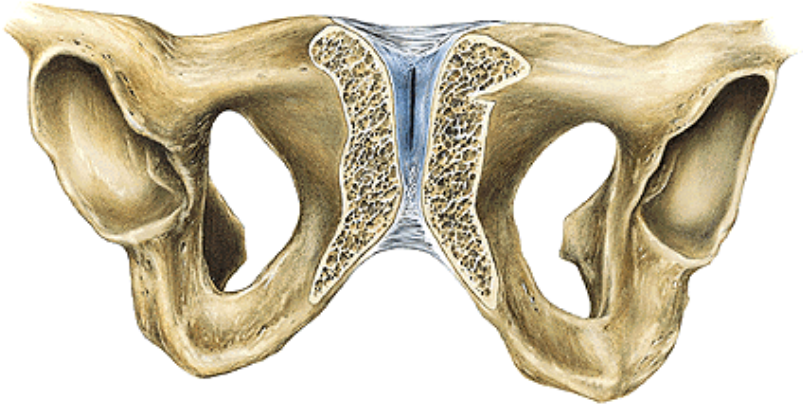


Synarthrosis (continuation)

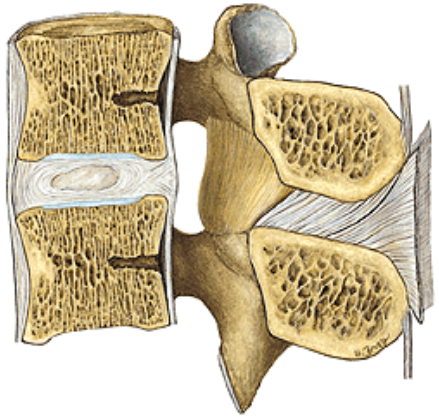
2. Synchondrosis

(cartilaginous joint)

Symphysis pubica

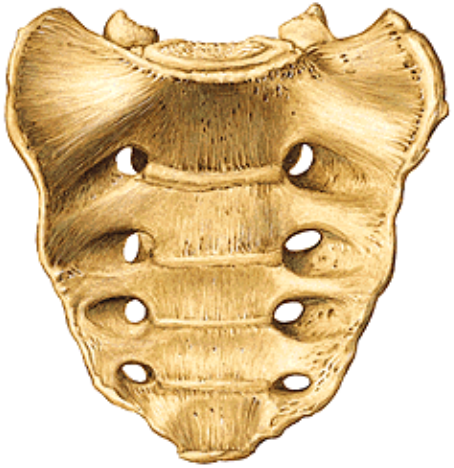


Discus intervertebralis *(intervertebral disc)*



3. Synostosis

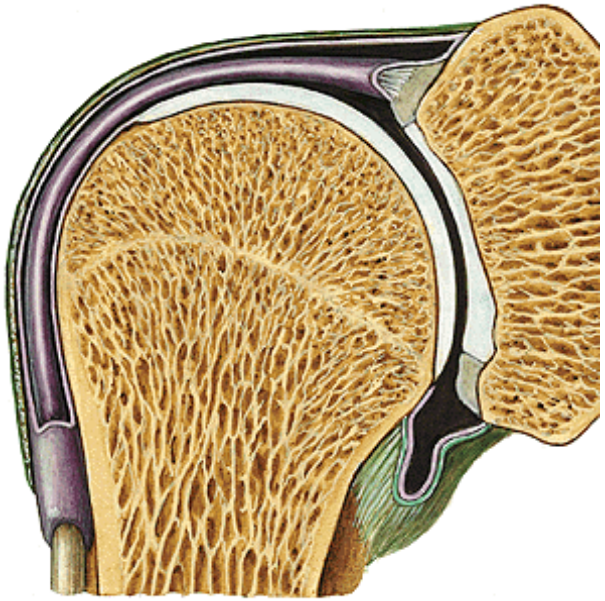
Os sacrum

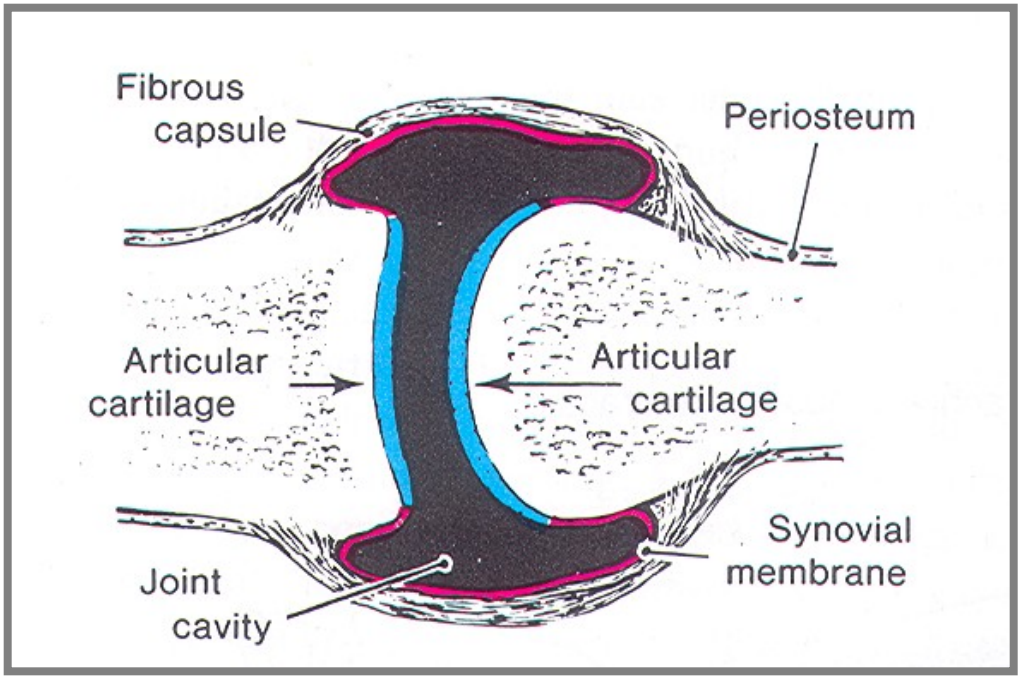


Os coccygis

II. Articulatio = *synovial joint* = Diarthrosis

movable connection of two or more bones by touch of contact articular surfaces covered by articular cartilage and with auxiliary facilities





General features of a synovial joint

(diarthrosis)

Facies articulares ***(articular surfaces)*** **(fossa articularis, caput articulare)**

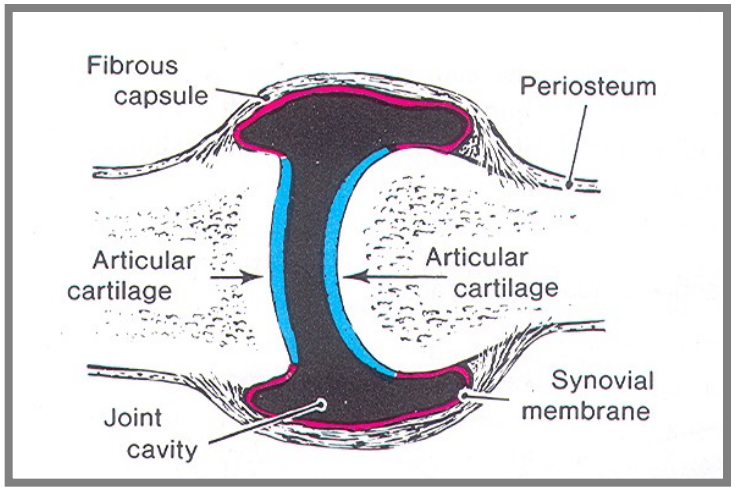
Capsula articularis ***(joint capsule)*** **= (stratum fibrosum and stratum synoviale) –** *fibrous and synovial layers*)

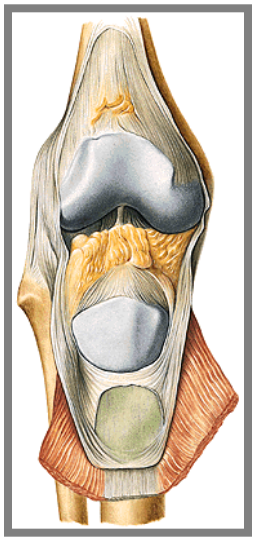
Cavitas articularis – capillary space filled by synovia *(articular cavity)*

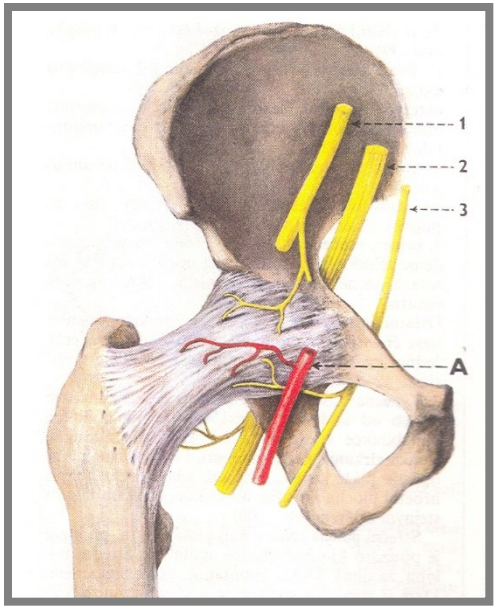
Synovia *(synovial fluid*) **–** nourishes the articular cartilage, increases adhesion and decreases friction of contact surfaces (lubricant)

Synovial plicae or synovial villi

Rete articulare *(Articular network) from vessels*





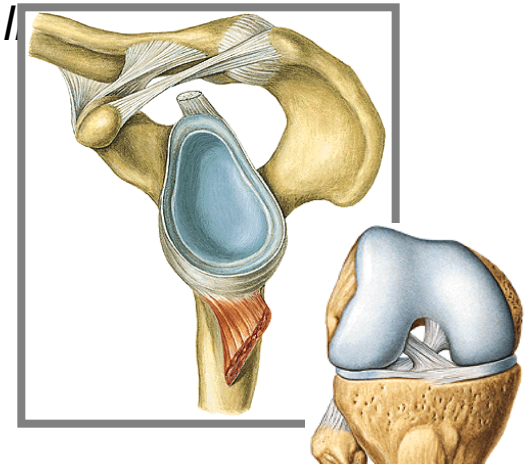


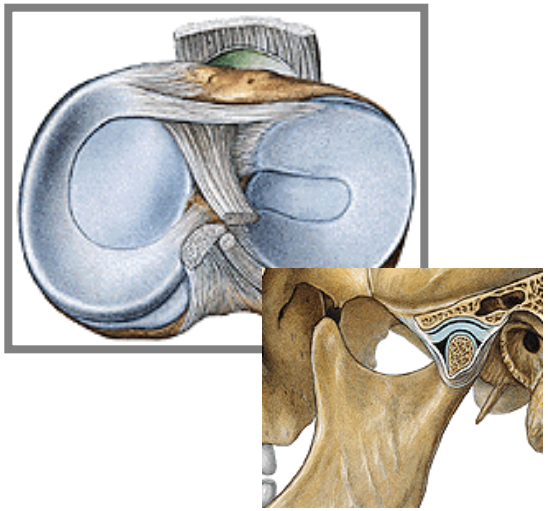
Auxiliary facilities of joints

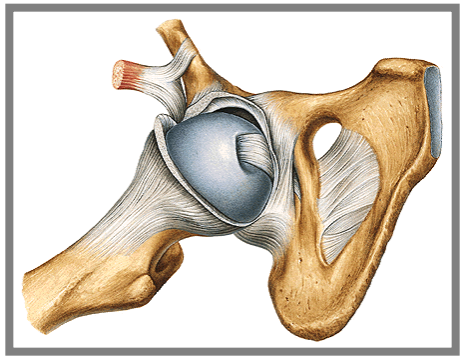
a) **labrum articulare** ***(articular lips)*** **–** ***fibrocartilaginous ring*** **– enlarge a shallow articular fossa by a strip of connective tissue and/or cartilage**

b) **disci and menisci articulares –** ***plates of cartilage*** **- serves as elastic pad, discs divide the articular cavity completely - into <u>two parts</u>, menisci only <u>partly</u>**

c) **ligamenta - present in the most joints as ligamenta capsularia, extracapsularia or intracapsularia** *(capsular, extracapsular or intracapsular l*

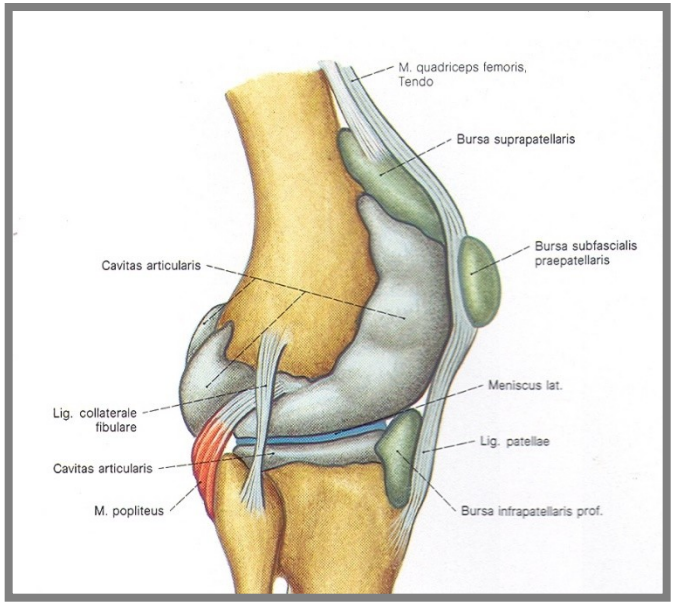


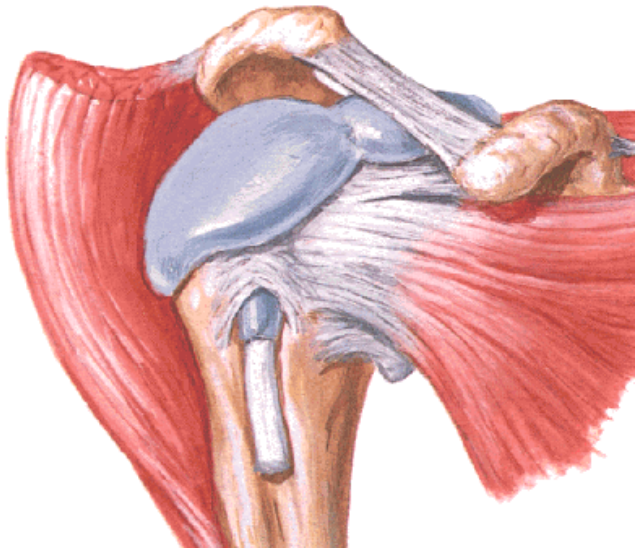




d) musculi articulares ***(articular muscles)*** prevent joint capsule of a strangulation

e) bursae synoviales ***(bursae and synovial pockets)*** – small cavities close to the joint, constructed by synovial membrane and synovial fluid, may communicate with the joint cavity. They decrease friction between tendons of muscles and bones.



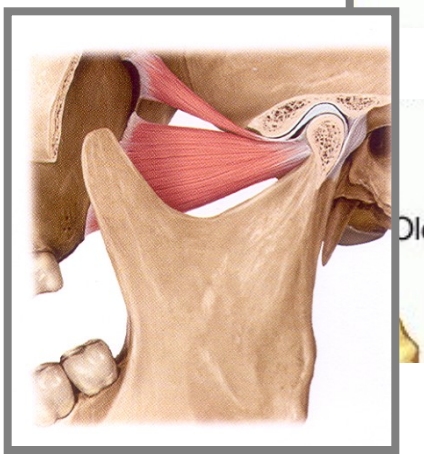


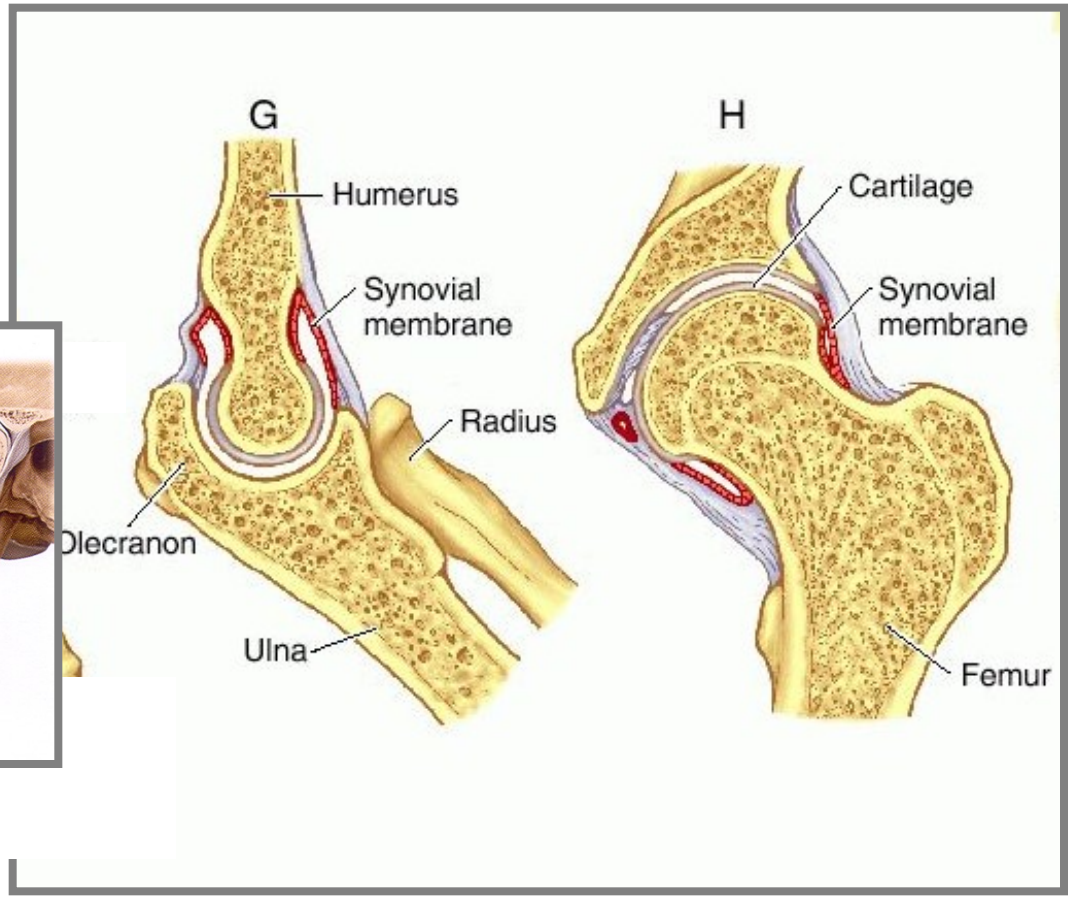
Division of joints

A. According to a number of bone in contact:

Articulatio simplex ***Simple joint***

Articulatio composita ***Compound joint***

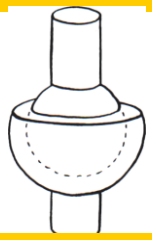




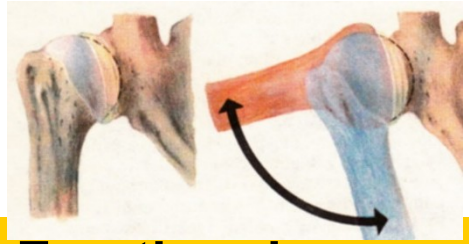
B. Division of joints according to the shape of articular surfaces:

Triaxial joints

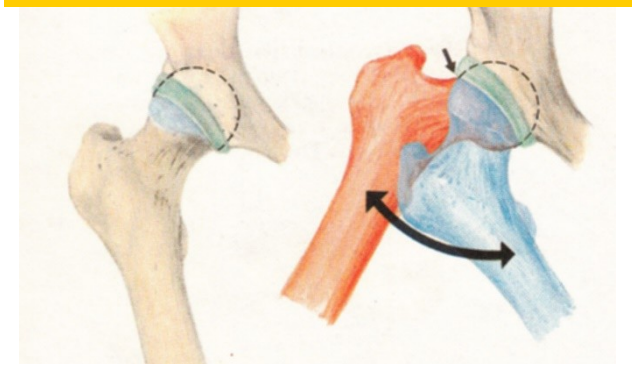
1. articulatio spheroidea
ball-and-socket joint



a) Arthrodia – free movements

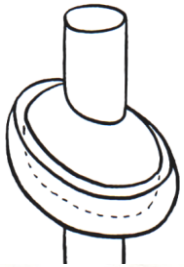


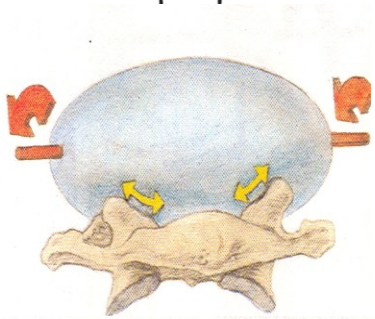
b) Enarthrosis –
restricted movements

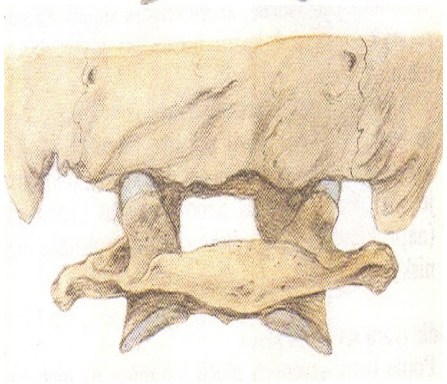


Biaxial joints

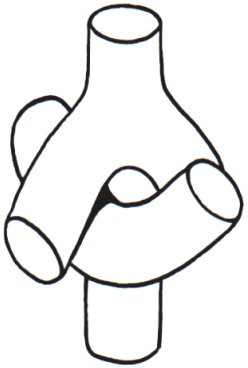
2. articulatio ellipsoidea
ellipsoidal (condyloid) joint

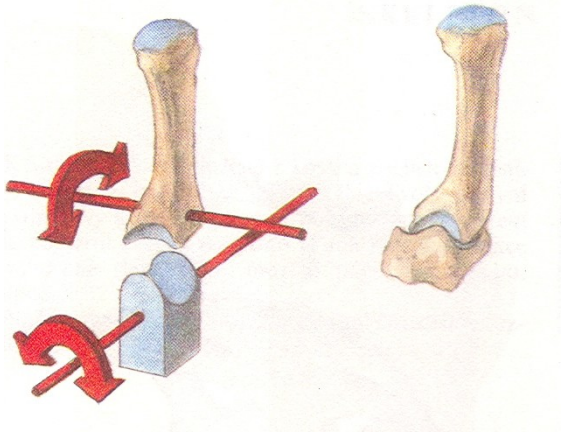






3. articulatio sellaris
saddle joint (sellar)

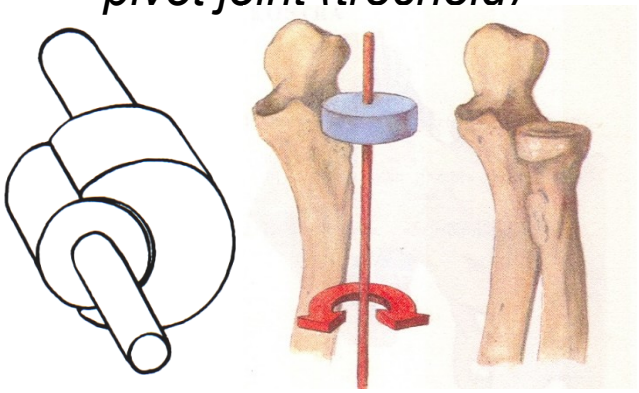




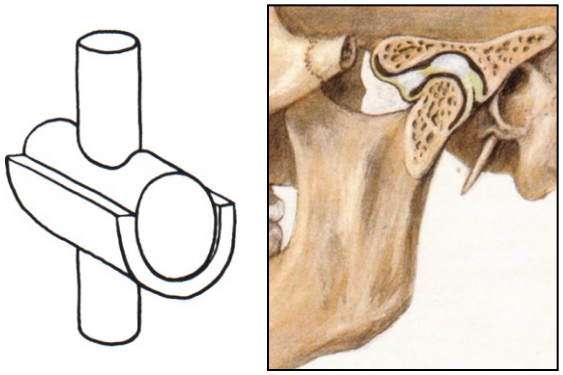
Monoaxial joints

4. Articulatio cylindroidea
cylindrical joint

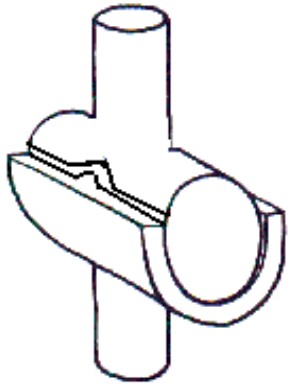
4a) Articulatio trochoidea
pivot joint (trochoid)

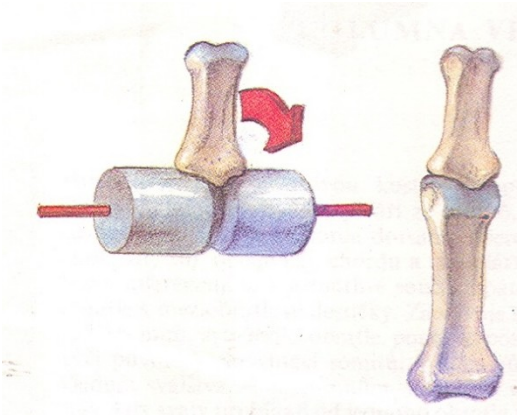


4b) ginglymus



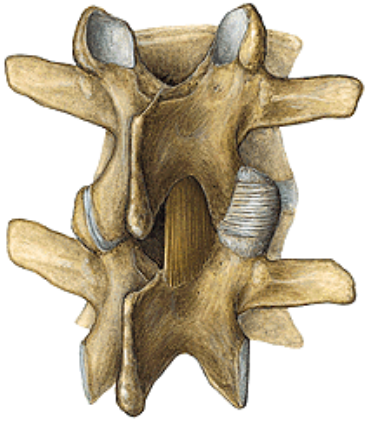
5) Articulatio trochlearis
hinge (trochlear) joint
(with ledge-shaped elevation)





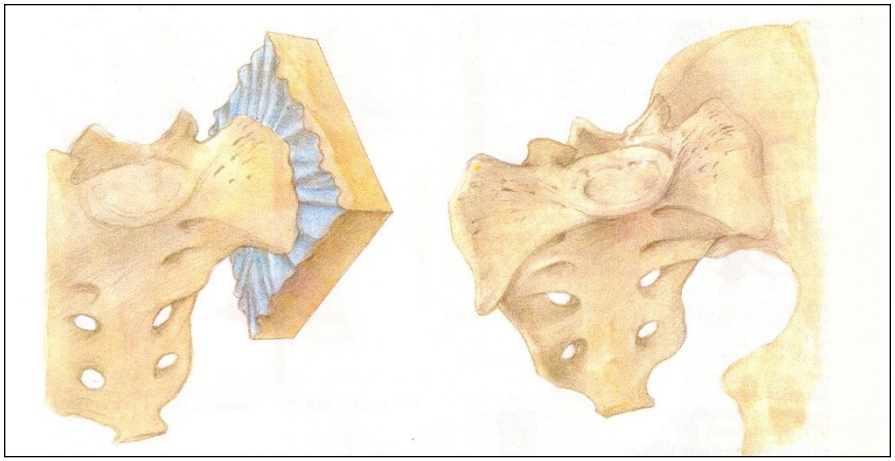
6. Articulatio plana

Joint with sliding movements



7. Amfiartrosis

Joint with minimal movements

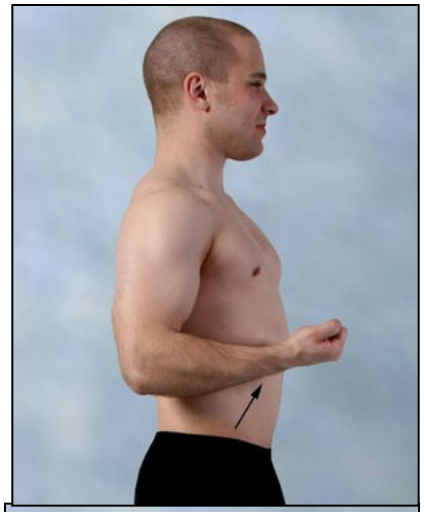


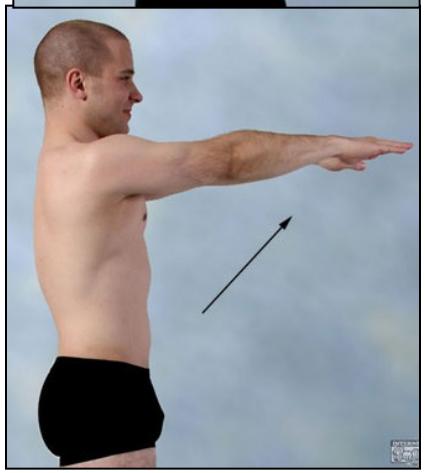
Midposition of the joint – position in which a joint capsule is evenly and maximum relaxed (the joint is the least loaded).

Movements in joints

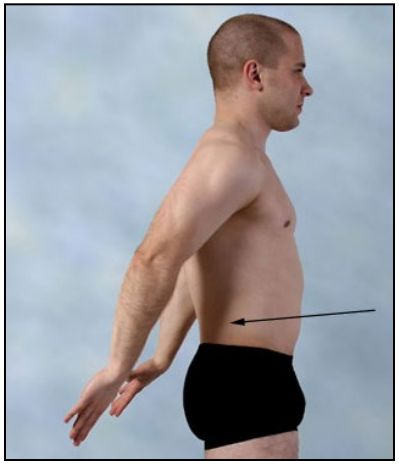
I.

flexion



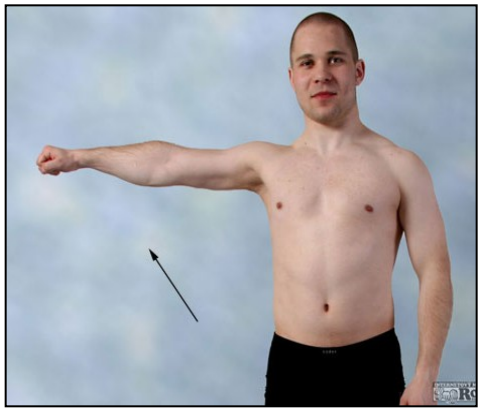


extension

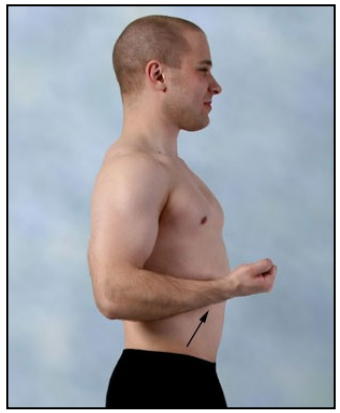


II.

abduction



adduction



III.

pronation

supination

Special arthrology

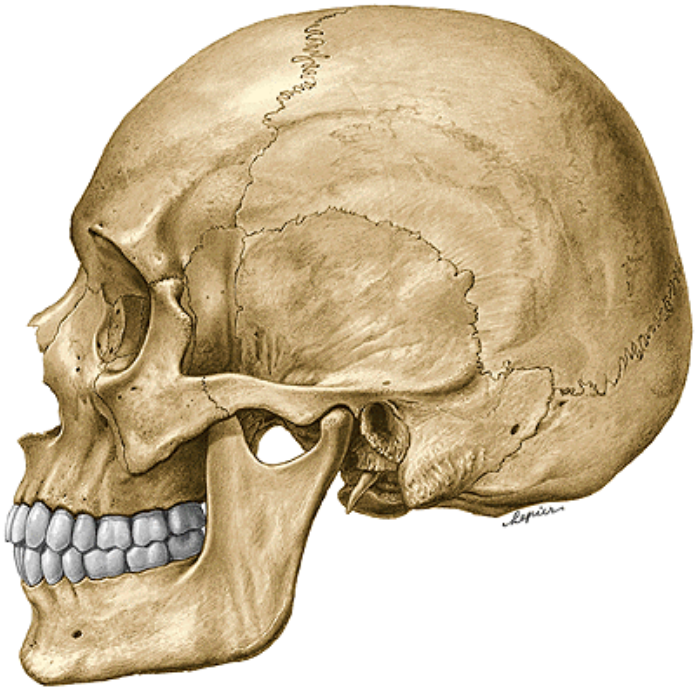
Connection on the skull

1. Craniovertebral connection
2. Skull syndesmoses and synchondroses
3. Temporomandibular joint
4. Connection of the os hyoideum *(hyoid bone)*

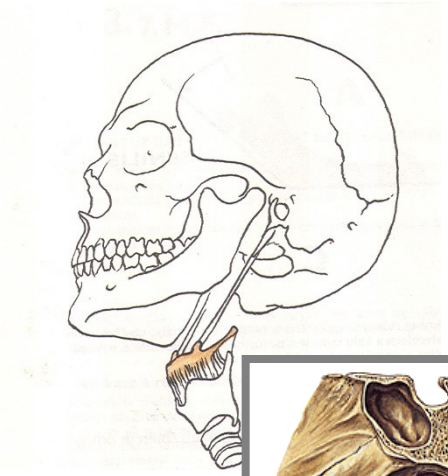
1. Connections of the skull

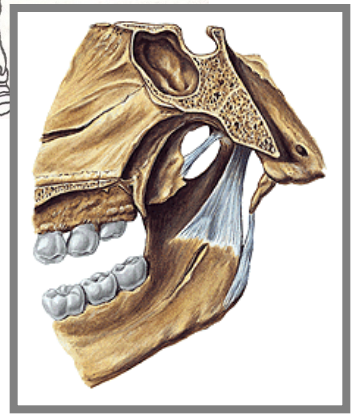
A. Synarthrosis (1. syndesmosis, 2. synchondrosis, 3. synostosis)
B. Diarthrosis=synovial joint (articulatio temporomandibularis)

I.1. Syndesmosis cranii



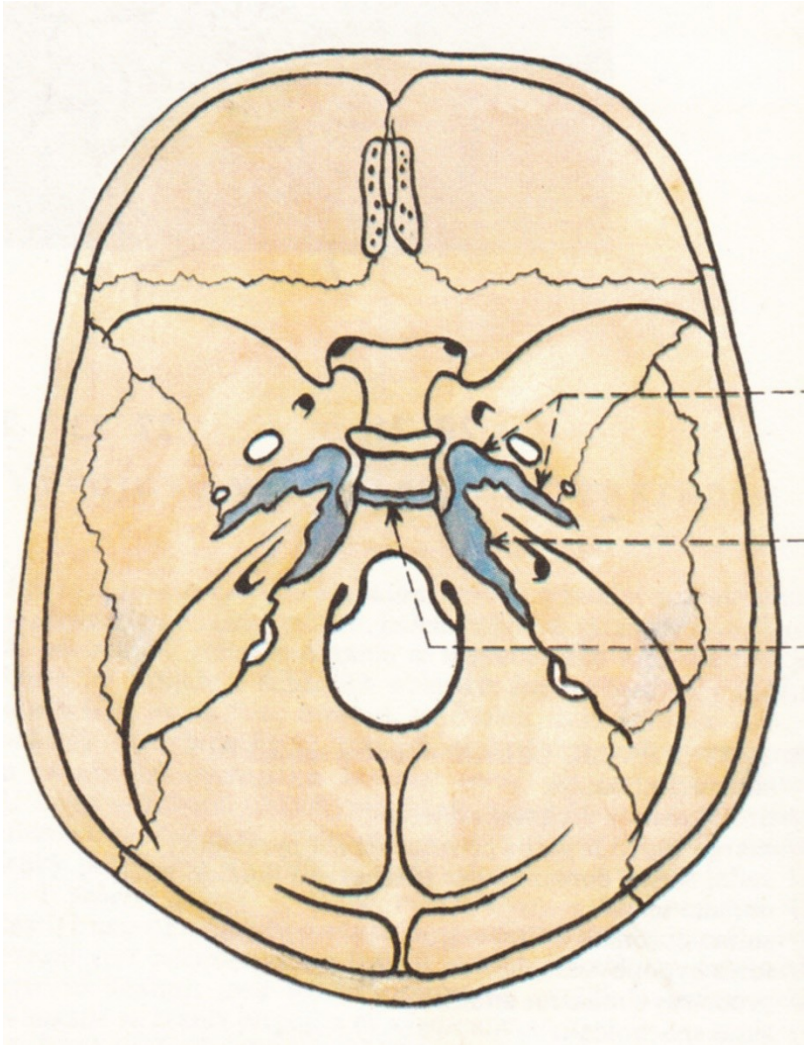
1. Suturae
2. Ligaments





ligamentum stylohyoideum
ligamentum stylomandibulare

I. 2. Synchondrosis of the skull



synchondrosis sphenopetrosa

synchondrosis petrooccipitalis

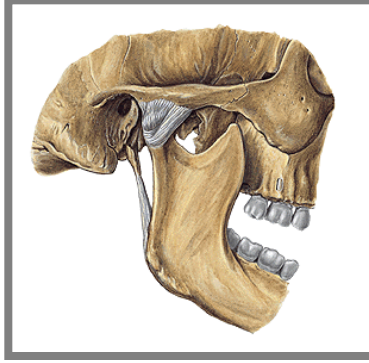
synchondrosis sphenooccipitalis

I. 3. Synostosis of the skull

synostosis sphenooccipitalis

Description (characterization) of synovial joints

1. Name of a joint
2. Articular surfaces
3. Articular capsule
4. Auxiliary facilities = additional features
5. Type of joint
6. Movements



Articulatio temporomandibularis

Temporomandibular joint **(compound)**

Articular surfaces: caput mandibulae with fossa mandibularis and tuberculum articulare of the temporal bone

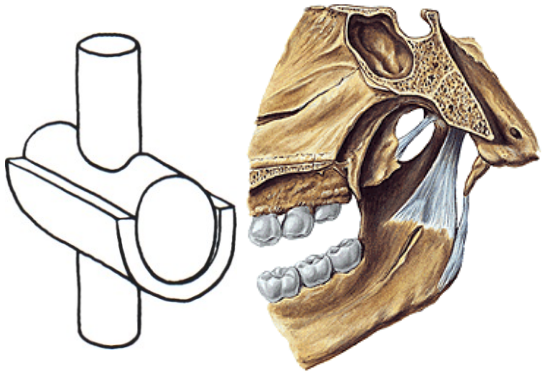
Articular capsule: is attached to the margins of contact articular surfaces, ventrally and dorsally is loose, its medial part is tense

Auxiliary facilities: discus articularis – with a thin center and thicker margins. It divides joint cavity into the upper pars discotemporalis (sliding movements) and lower pars discomandibularis (rotary movements). Lig. laterale.

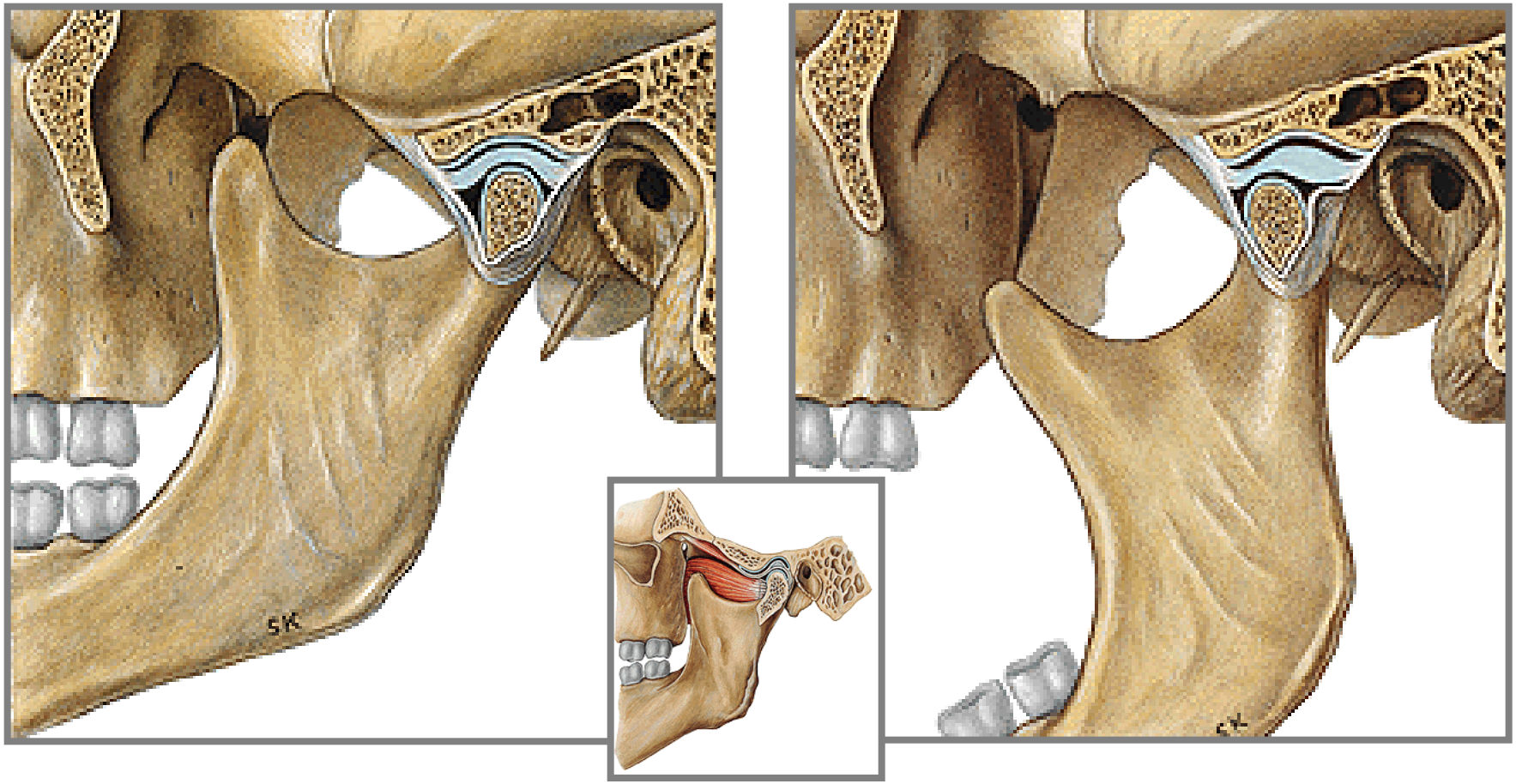
Close to the joint are located lig. sphenomandibulare and lig. stylomandibulare

Type of joint: compound and paired joint (Ginglymus)

Movements: complicated (rotary, sliding, chewing movements)



Movements: opening (mandibular depression) and closing mouth (elevation), rotary and sliding movements and chewing movements - mandibular protraction (movement of mandible ventrally) and retraction movement of mandible dorsally)



I. Craniovertebral joints

1. Articulatio atlantooccipitalis – *(atlanto-occipital joint)*

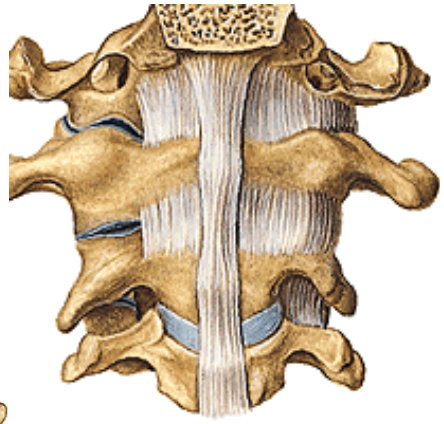
articular surfaces:

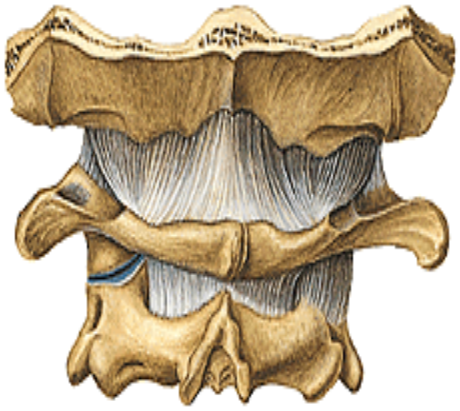
articular capsule: **is attached to the margins of the articular surfaces**

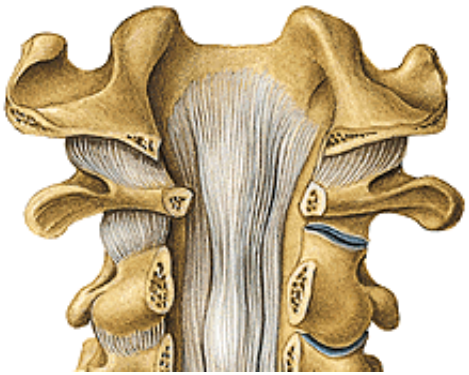
auxiliary facilities: **shares with articulatio atlantoaxialis**

type of joint: **art. ellipsoidea** ***(ellipsoid joint)***

movements: **flexion and extension of the head and its minimal lateral motion**





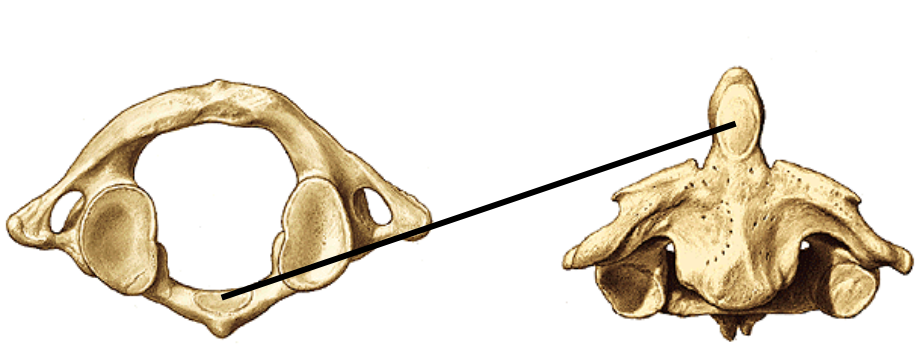


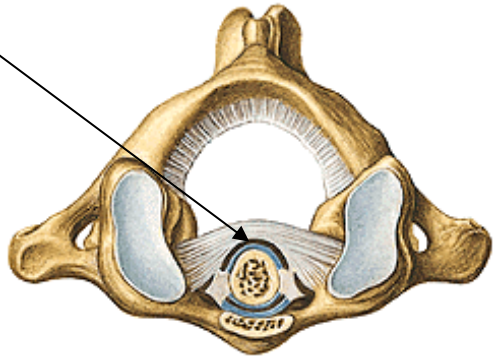
2. Articulatio atlantoaxialis – a compound joint

Articular surfaces:

2a. Articulatio atlantoaxialis mediana

facies articularis anterior dentis and fovea dentis atlantis
facies articularis posterior dentis and lig. transversum atlantis





2b. Articulatio atlantoaxialis lateralis

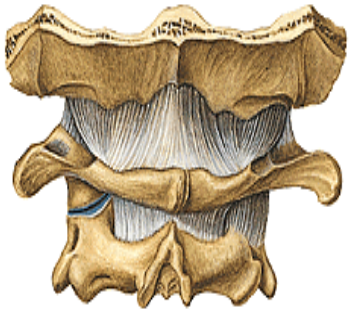
facies articulares inferiores atlantis
processus articulares superiores axis

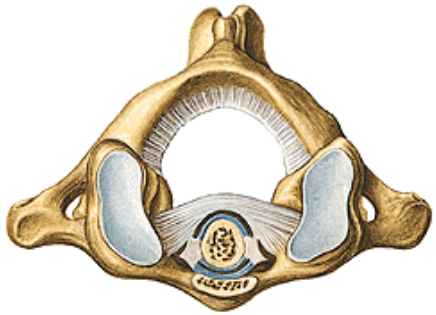
Articulatio atlantoaxialis mediana et lateralis

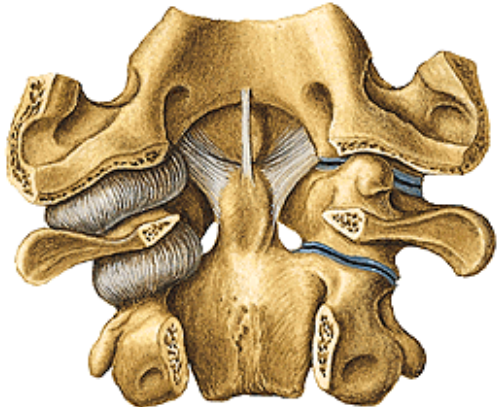
Articular capsule: share both 1) and 2) joints and is attached to the margins of contact articular surfaces

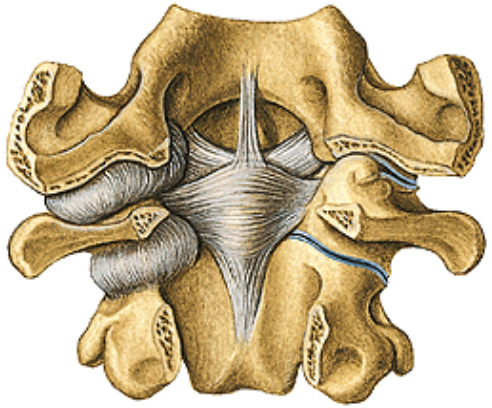
Auxiliary facilities: lig. apicis dentis, ligg. alaria, lig. transversum atlantis, lig. cruciforme atlantis = lig. transversum atlantis and fasciculi longitudinales *(longitudinal bands)*
membrana atlantooccipitalis anterior and posterior *(Anterior and posterior atlantooccipital membranes)*
membrana tectoria

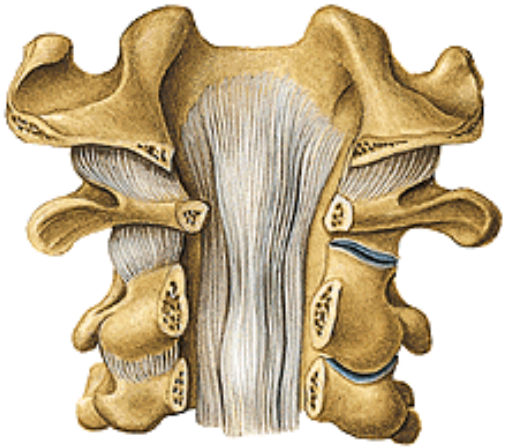
Type of joint: **functionally – the mechanical unit. Atlas rotates around dens axis in about 60°**









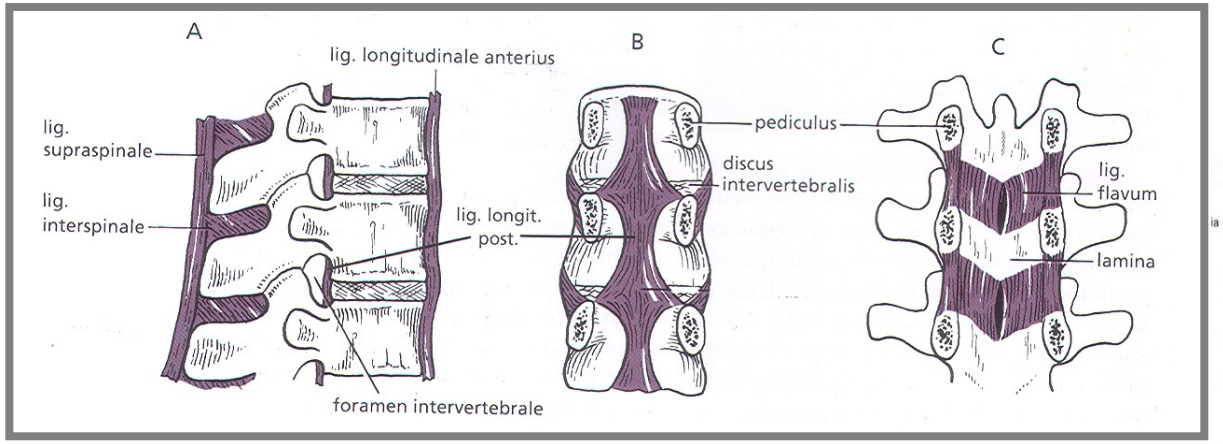


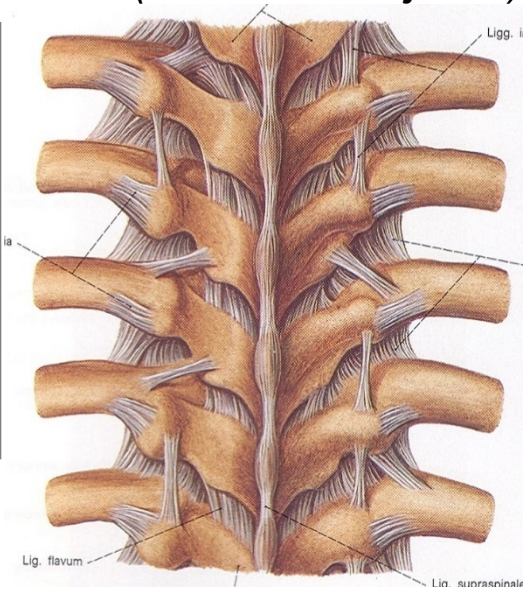
Juncturae columnae vertebralis *(Junctions of the spine)*

There are both synarthrosis *(fibrous joints)* and diarthrosis *(synovial joints)* on the spine.

A) Connections of adjacent vertebrae

1. **between vertebral <u>bodies</u> – by discs intervertebrales *(23)***
2. **between vertebral <u>arches</u> by ligg. flava**
3. **between vertebral <u>processes</u> by ligg. intertransversaria, interspinalia and supraspinale (lig. nuchae)**
4. **Synovial joints** (diarthrosis) **– articulationes intervertebrales** *(intervertebral joints)*





1. Connection between vertebral bodies

Anulus fibrosus - tense

Nucleus pulposus

Serves as a spherical bearing

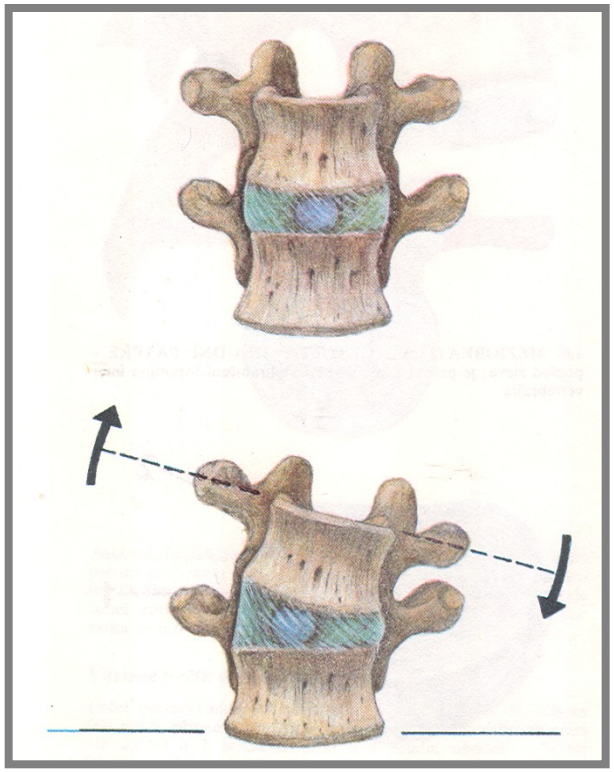
= jelly-like nucleus – remnant of chorda dorsalis

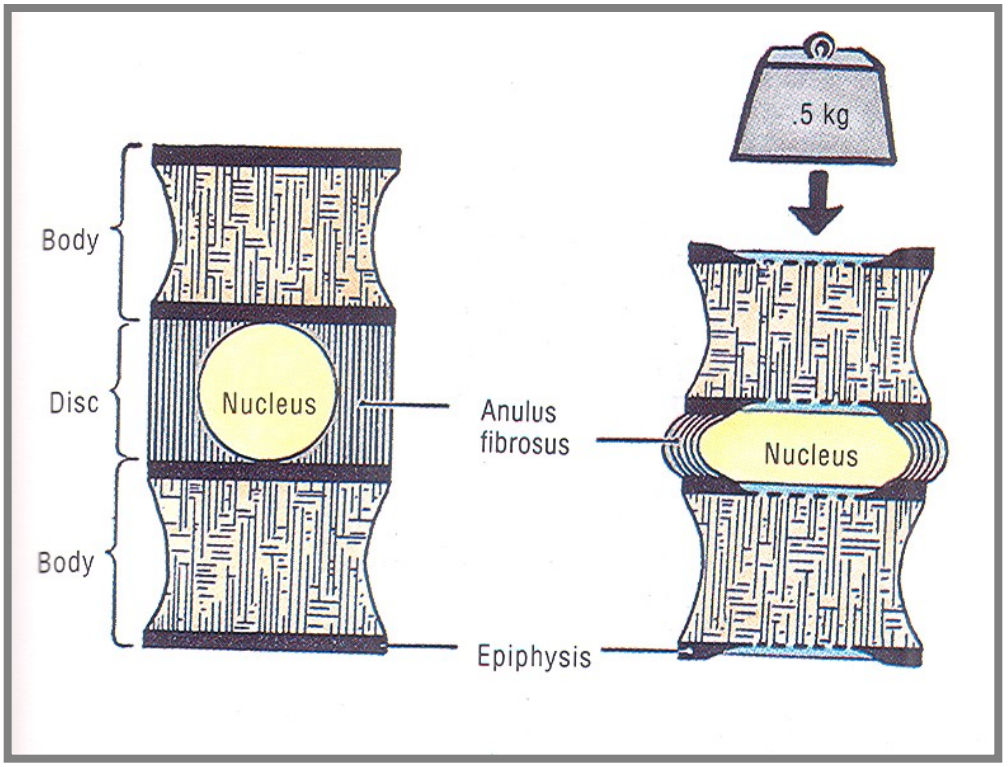
=spherical focus for movement

discus intervertebralis

(intervertebral disc)

23 discs, form about ¼ of the spine length





Compression of disc (exchange of water with vertebral veins)

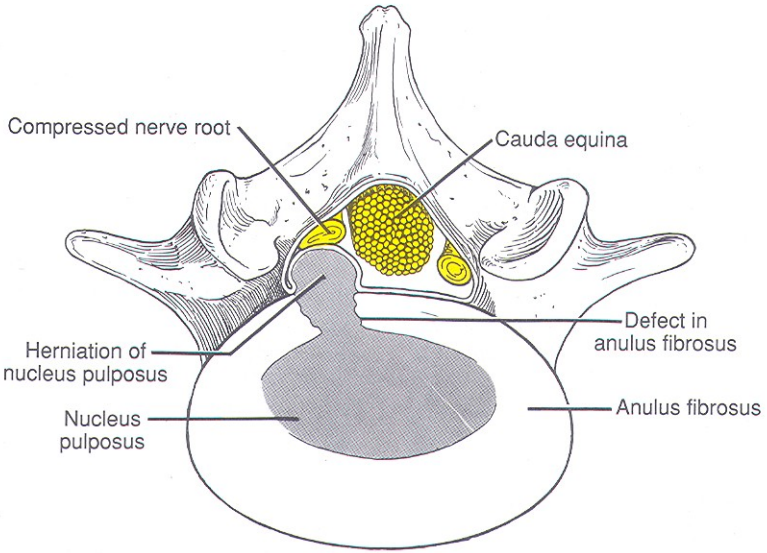
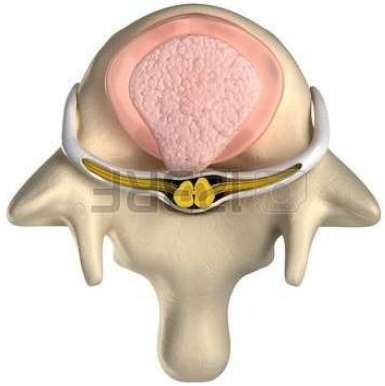
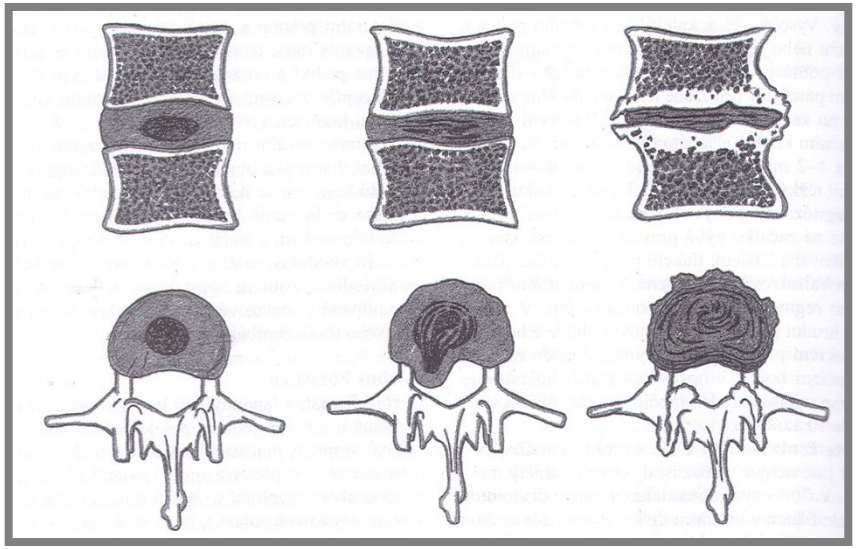
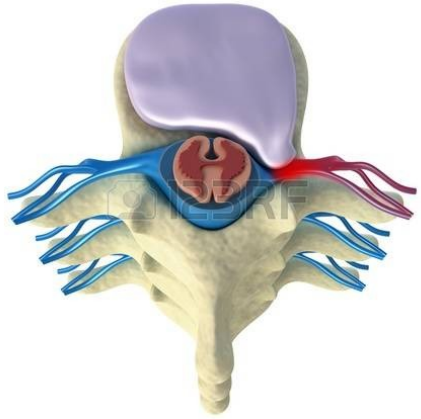


Figure 4-32. An illustration showing how an intervertebral disc protrusion may exert pressure on a spinal nerve root and/or the cauda equina.

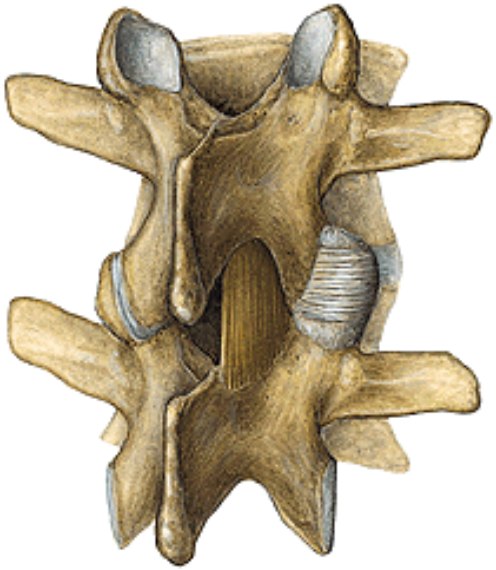


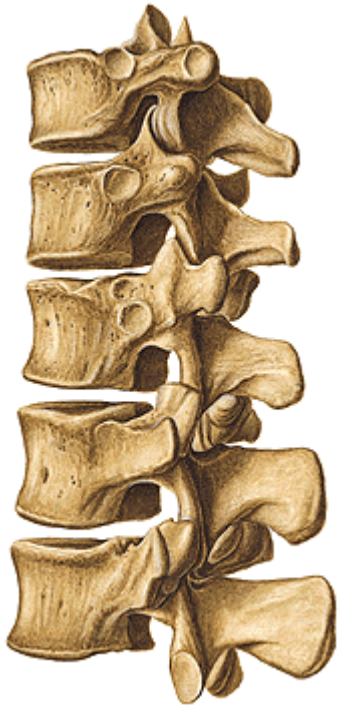




Articulationes intervertebrales *(intervertebral joints)*

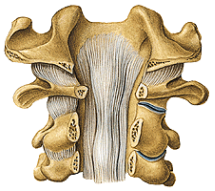
Articular surfaces: processus art. sup. and inf. of adjacent vertebrae
(position of articular surfaces - C oblique, Th frontal, L sagittal)
Articular capsule: is attached to the margins of contact articular surfaces
Type of joints: articulatio plana (*flat joints)*
Movements: sliding

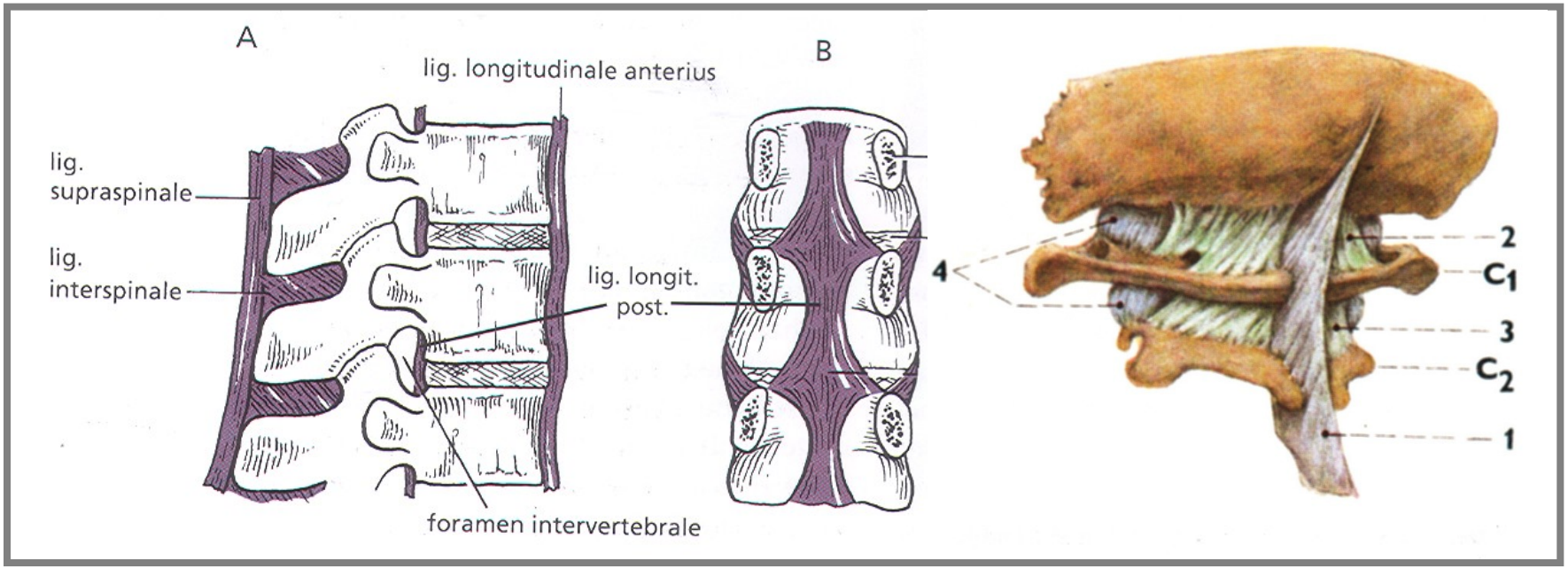


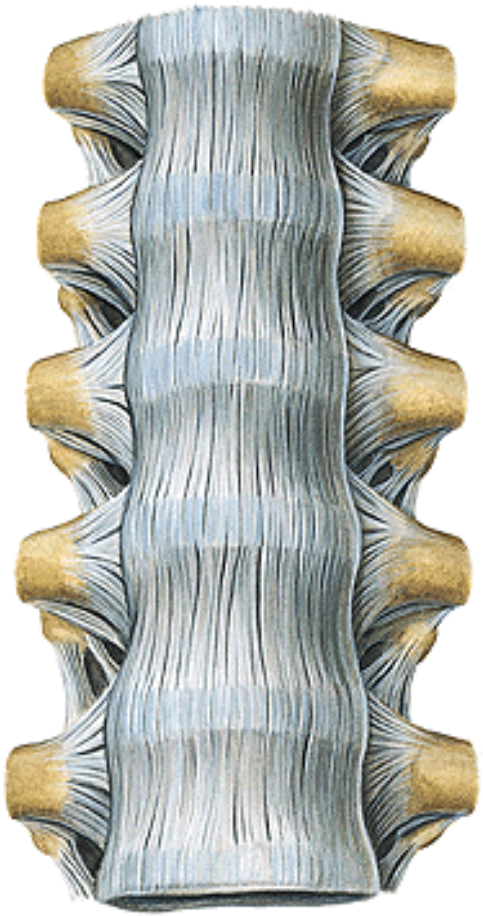


B) Common connections for all vertebrae (tie vertebral column)

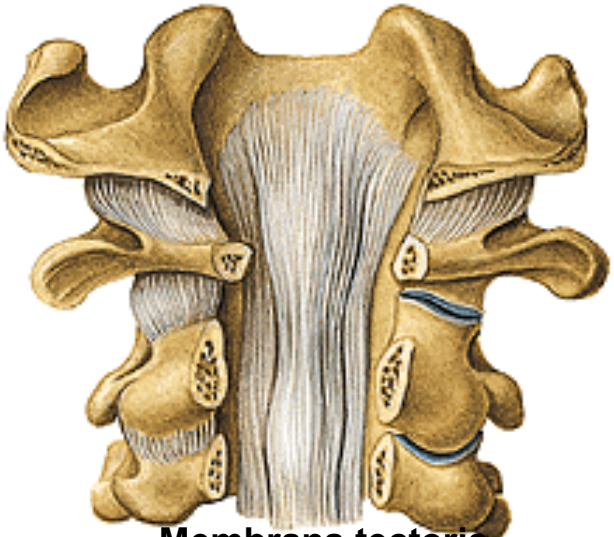
Lig. longitudinale anterius - *anterior longitudinal ligament*
Lig. longitudinale posterius – *posterior longitudinal lig.*
continues cranially as **membrana tectoria**
caudal continuation of both – **ligg. sacrococcygea**
Lig. supraspinale - continues cranially as lig. nuchae



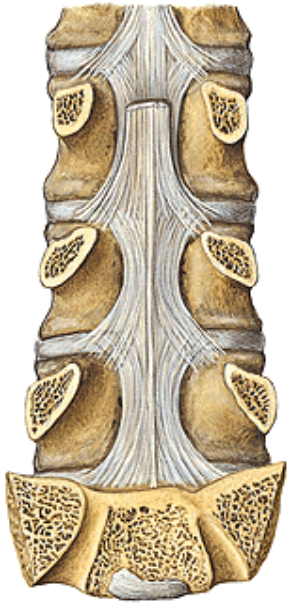




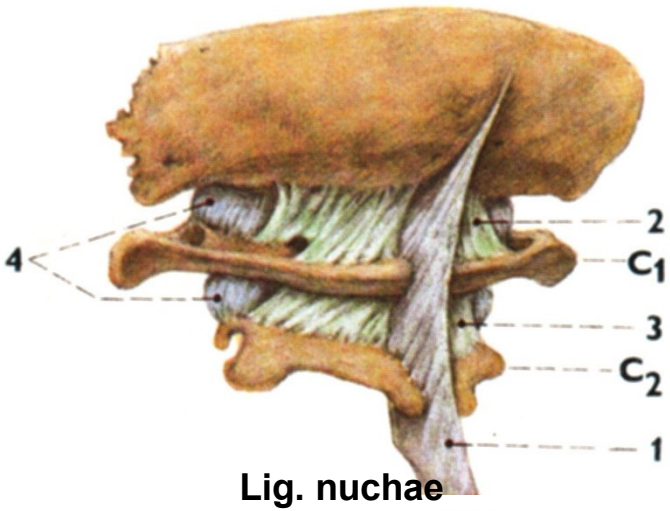
Lig. longitudinale anterius



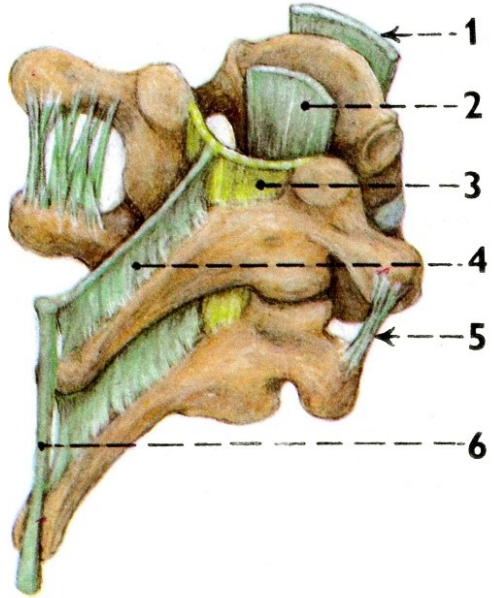
Membrana tectoria



Lig. longitudinale posterius



Lig. nuchae

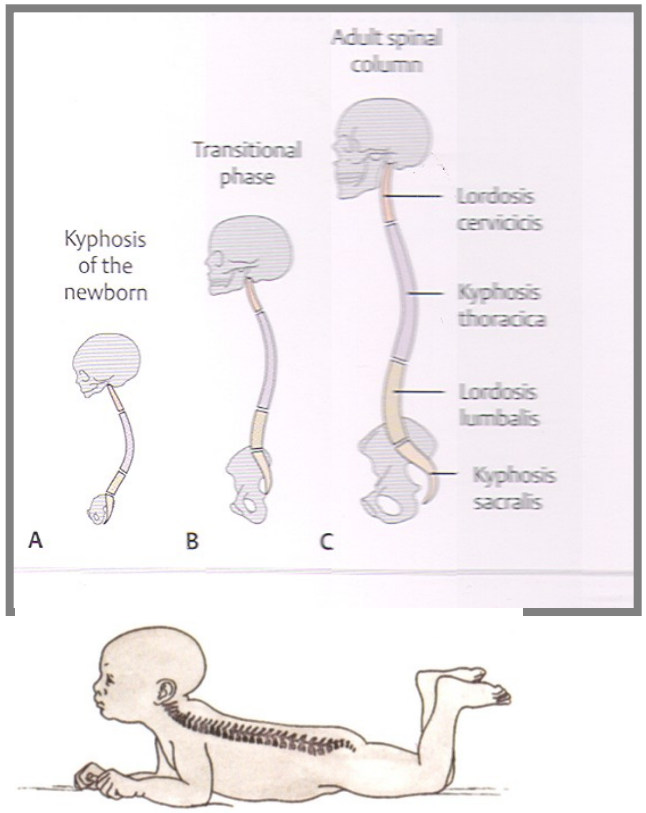


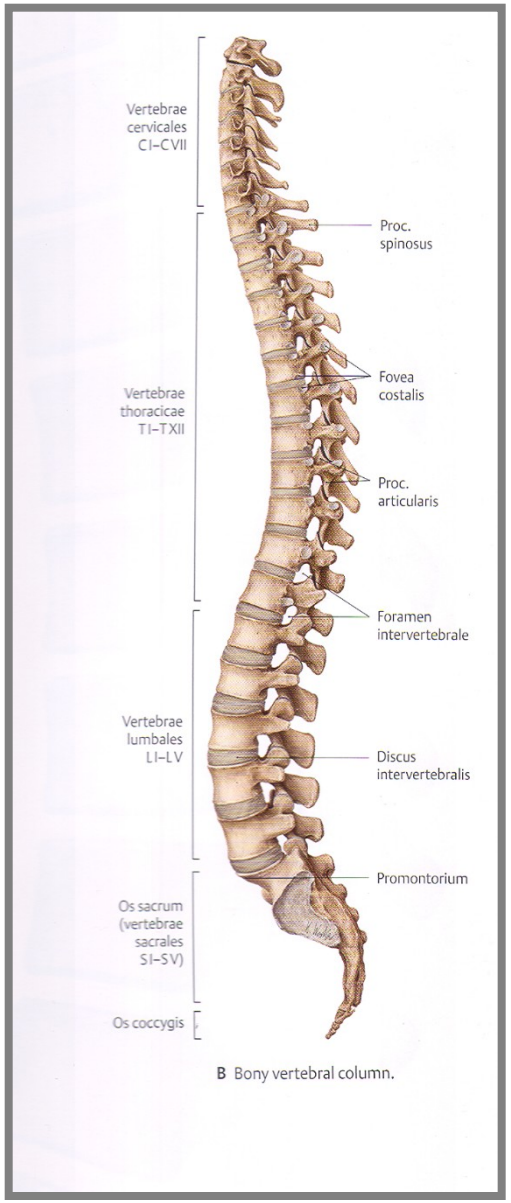
Lig. supraspinale

Shape and curvature of spine

Spine has <u>cervical and lumbar</u> lordosis (C4-5, L3-4) and <u>thoracic and sacral</u> kyphosis (Th6-7)

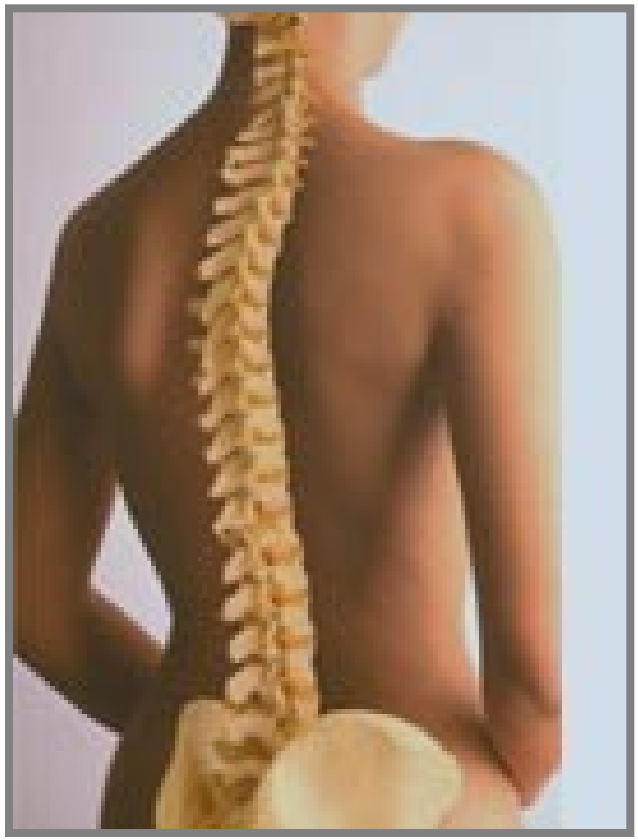
hyperkyphosis



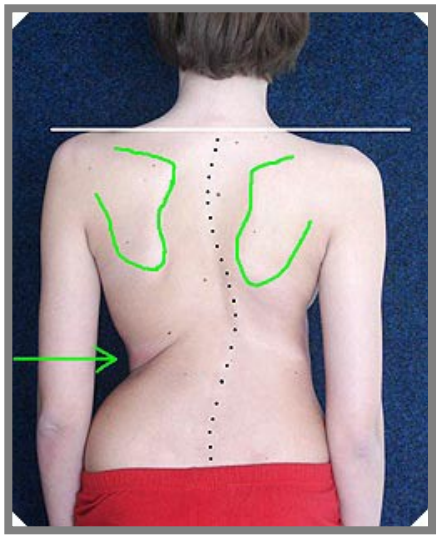


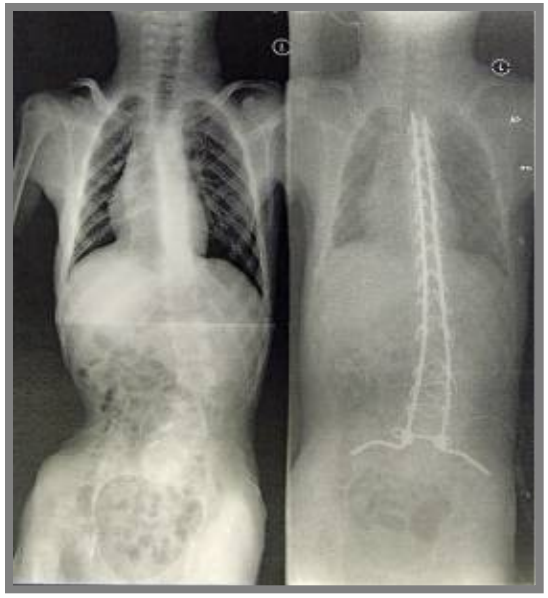
B Bony vertebral column.

Curvature of the spine in frontal plane – *skoliosis*



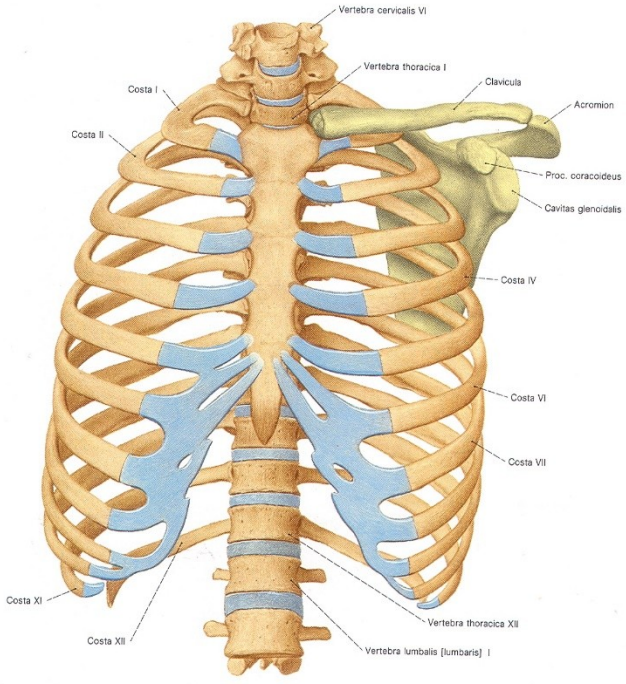
Physiological skoliosis Th_{3-5}





II. Shape of thorax *(chest)*

a) **Ventral wall – sternum, costal cartilages and ribs**
b) **Lateral wall – anguli costae**
c) **Dorsal wall – vertebrae thoracicae and bone parts of the ribs**
d) **Entrance (apertura thoracis superior) is limited by the 1. thoracic vertebra, the 1. rib and cranial margin of sternum**
e) **Exit (apertura thoracis inferior) is limited by 12. thoracic vertebra, 12. and 11. ribs and *arcus costarum.***



Connections of the thorax

I) Juncturae thoracis *(connections of thoracic cage)*

A. *Articulationes costovertebrales* *(costovertebral joints)*

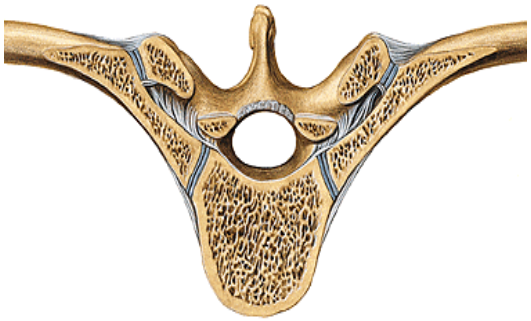
1. *Articulationes capitis costae* *(joints of the rib head)*

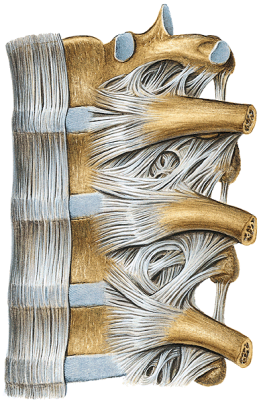
Articular surfaces: **facies articularis capitis costae** and **foveae costales** of the thoracic vertebrae bodies

Articular capsule: is attached to the margins of contact articular surfaces

Auxiliary facilities: **lig. capitis costae radiatum**
lig. capitis costae intraarticulare (2. – 10. ribs)

Movements: – around axis paralel to the collum costae *(neck of rib)*





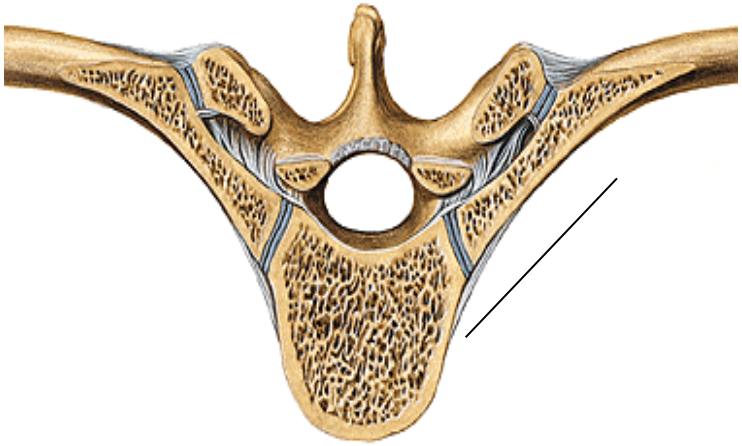
2. Articulationes costotransversariae

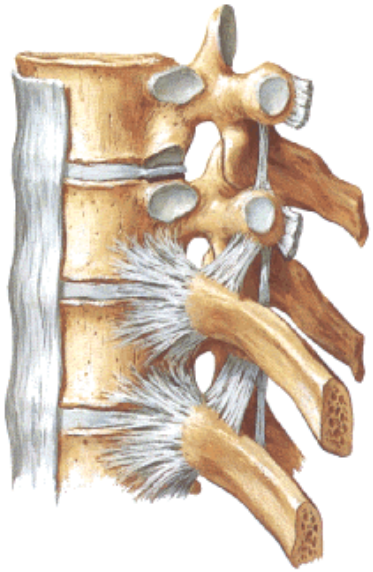
Articular surfaces: **foveae costales transversales** and **facies articularis tuberculi costae**

Articular capsule: is attached to the margins of contact articular surfaces

Auxiliary facilities : **ligg. costotransversaria, ligg. costotransversaria lateralia** and **superiora**

Movements: – around axis paralel to the central line of the collum costae





B. Juncturae sternocostales (*sternocostal articulations*)

1. **Synchondrosis sternocostalis** (1st rib)
2. **Articulationes sternocostales** *(sternocostal synovial joints)*

Auxiliary facilities: **ligg. sternocostalia radiata form membrana sterni externa and interna**

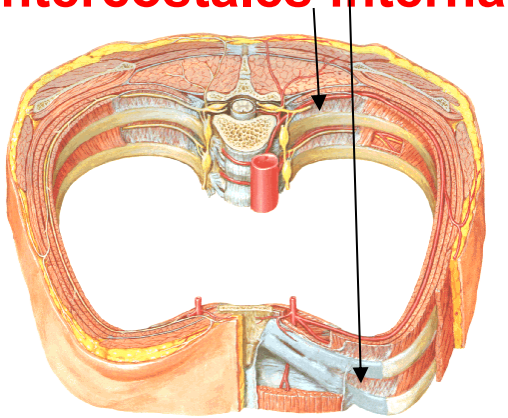
C. Connection of 5th – 9th ribs

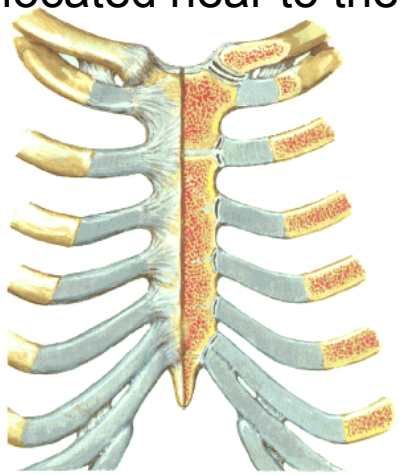
1. Articulationes interchondrales *(interchondral joints)* – *false ribs*

2. Membranae intercostales

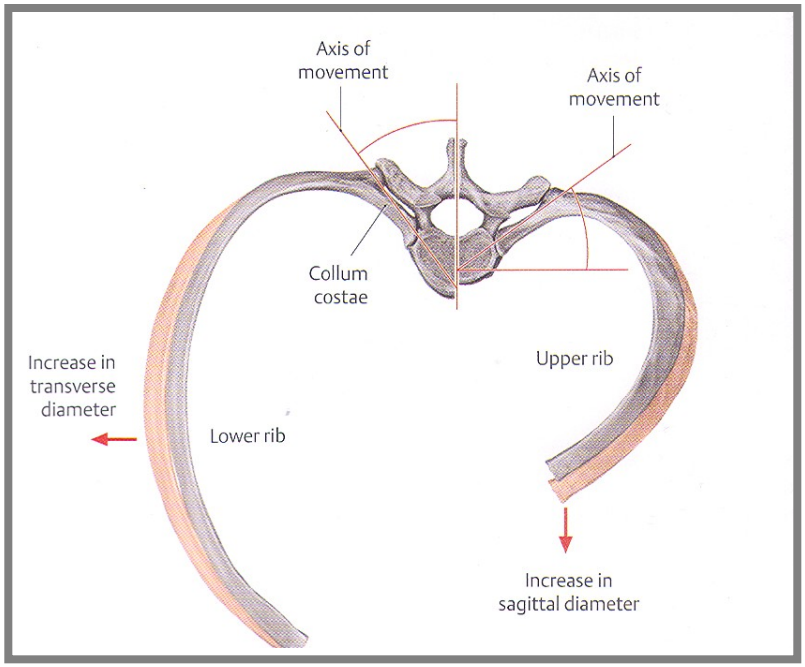
a) membranae intercostales externae - between costal cartilages close to the sternum

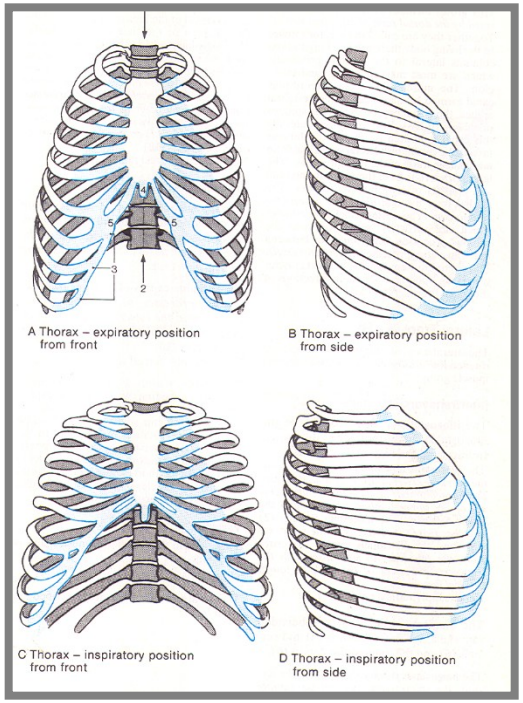
b) Membranae intercostales internae are located near to the spine





III. Movements of thorax (chest)

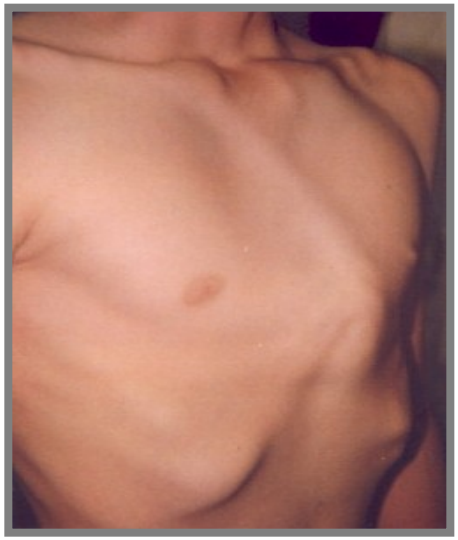




in costovertebral joints - rotation along longitudinal axis - runs through collum costae
increasing volume of the chest - inspiration *(inspire)*
decreasing volume of the chest - expiration *(expire)*

Pathological shape of thorax

Pectus excavatum
(sunken)



Pectus carinatum
(raised)

Upper limb connections

(juncturae ossium extremitatis superioris)

1) Articulationes cinguli membri superioris

Connections of shoulder girdle

2) Articulationes membri superioris liberi

Connections of the free part of the upper limb

Articulationes cinguli membri superioris

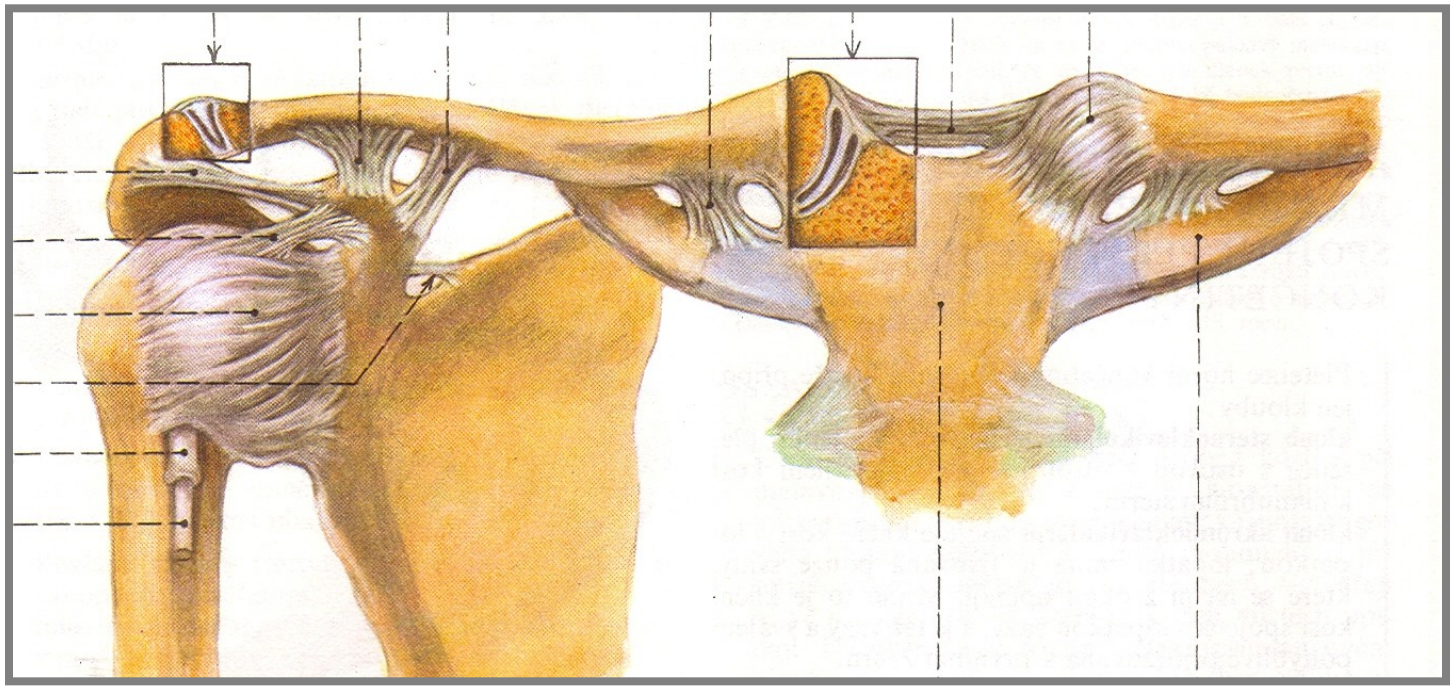
(Connections of shoulder girdle)

1. Articulatio sternoclavicularis *(sternoclavicular joint)*

ligg. sternoclaviculare ant. and post., interclaviculare, costoclaviculare + disc

2. Articulatio acromioclavicularis *(acromioclavicular joint)*

ligg. acromioclaviculare, coracoclaviculare (disc?)



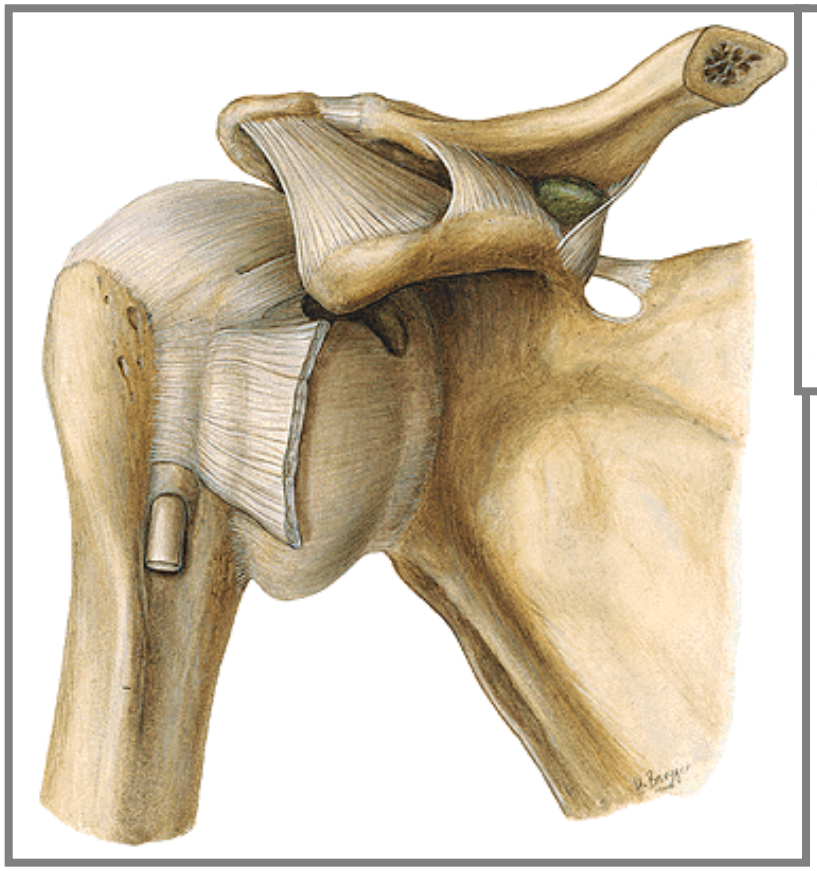
3. Syndesmosis *(Ligaments)* of the scapula

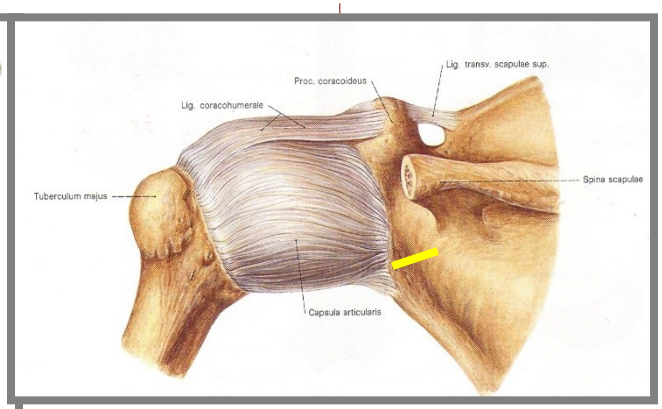
Lig. transversum scapulae *(transversal scapular ligament)*

Lig. coracoacromiale *(coracoacromial ligament)* - together with both bone processus forms

fornix humeri

Abduction/elevation of the upper limb is always associated with movements of scapula!

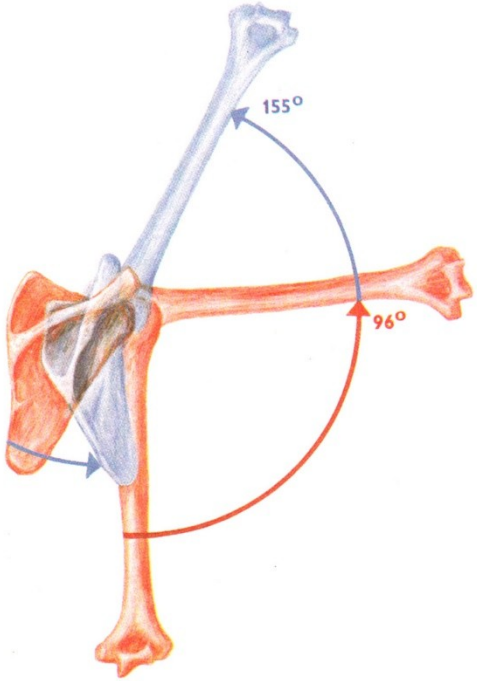




Movements of scapula

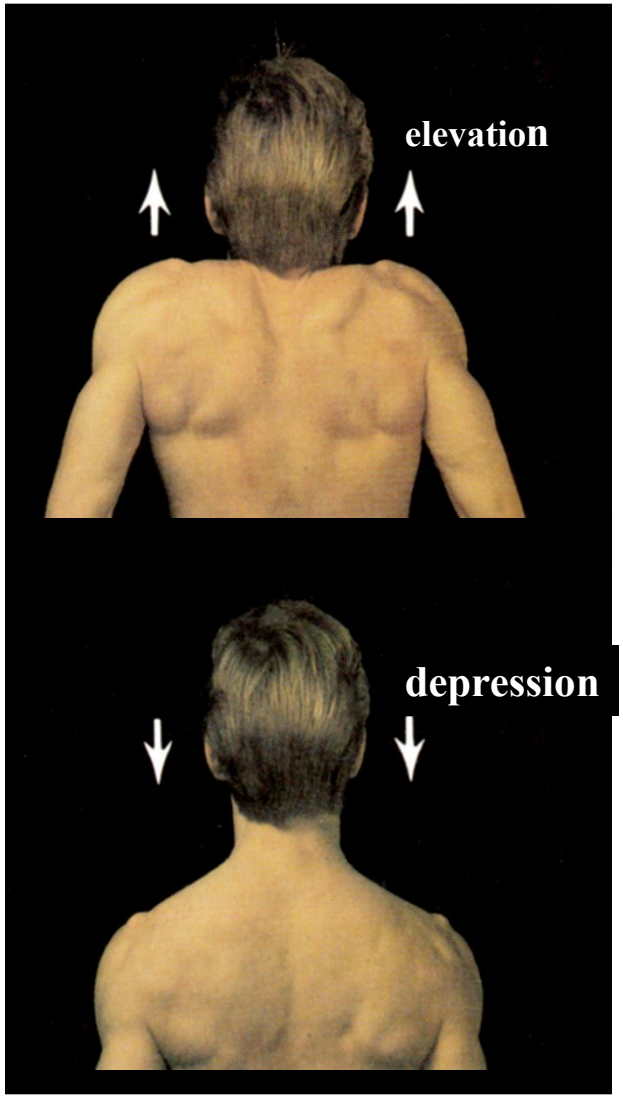
(lateroventrally,
stretching arms forward)

(dorsomedially,
stretching arms backward)



elevation

depression



B) Articulationes membri superioris liberi

Connections of the free part of the upper limb

1. Articulatio humeri *(Shoulder joint)*

Articular surfaces:

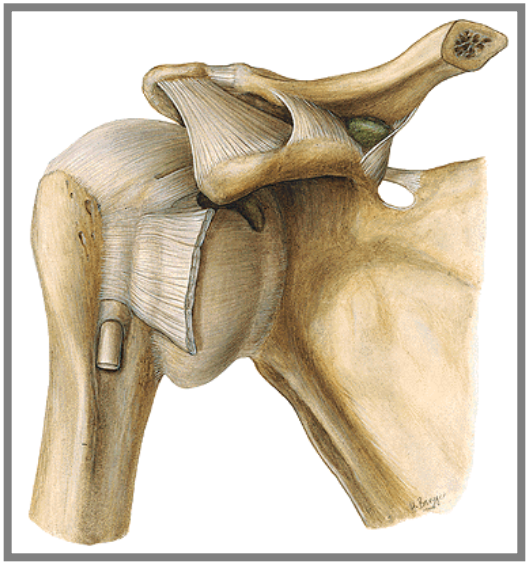
Articular capsule: on the medial side of humerus runs more distally

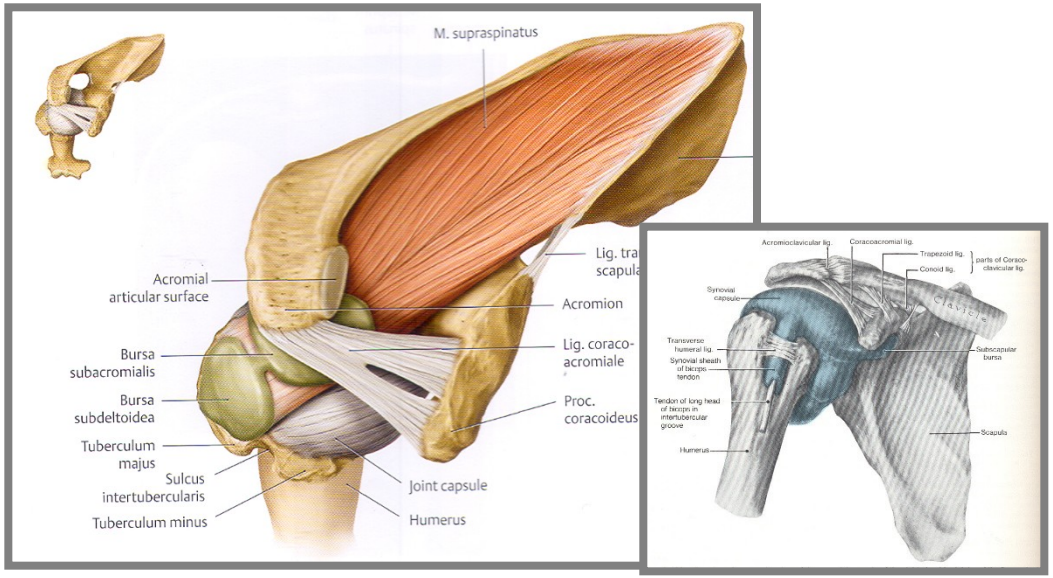
Vagina synovialis intertubercularis

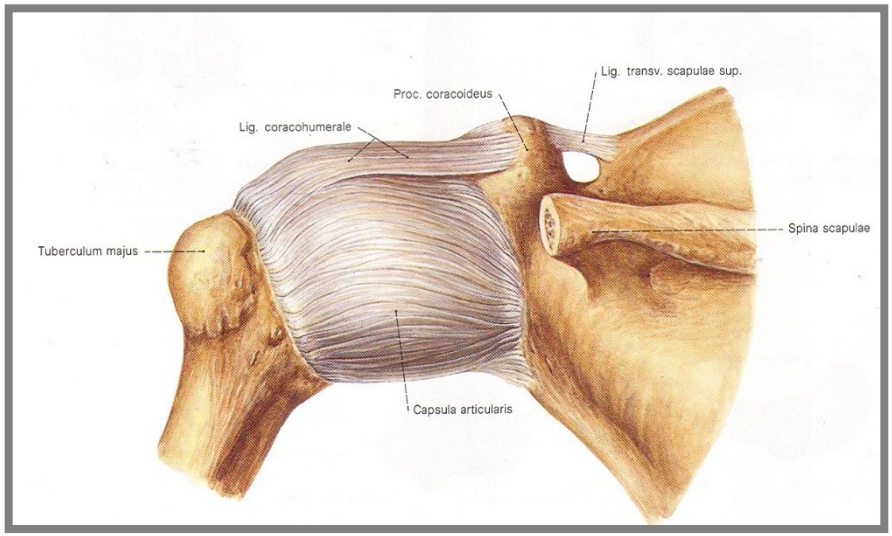
Auxiliary facilities: labrum glenoidale, ligg. glenohumeralia, lig. coracohumerale. Articular capsule is reinforced by tendons of muscles (m. subscapularis, m. supraspinatus, m. infraspinatus, m. teres minor - ***rotator cuff***).

Type of joint: arthrodia *(ball-and-socket),* three degrees of movements freedom.

Middle position of the joint - flexion and abduction at about 40-45°, synovial bursae







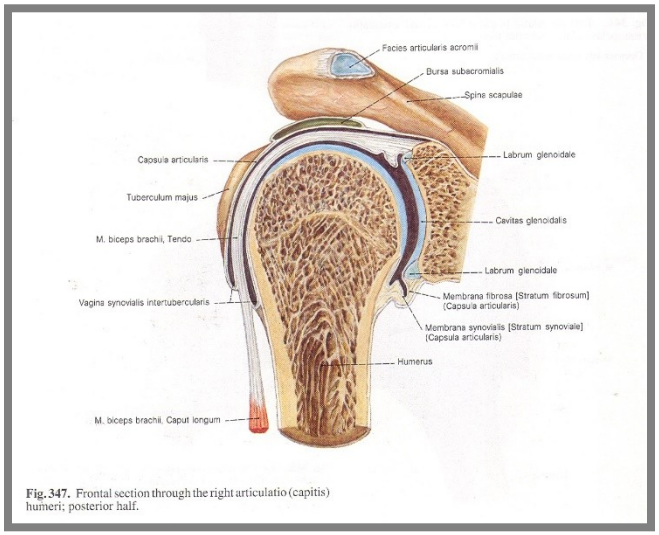


Fig. 347. Frontal section through the right articulatio (capitis) humeri; posterior half.

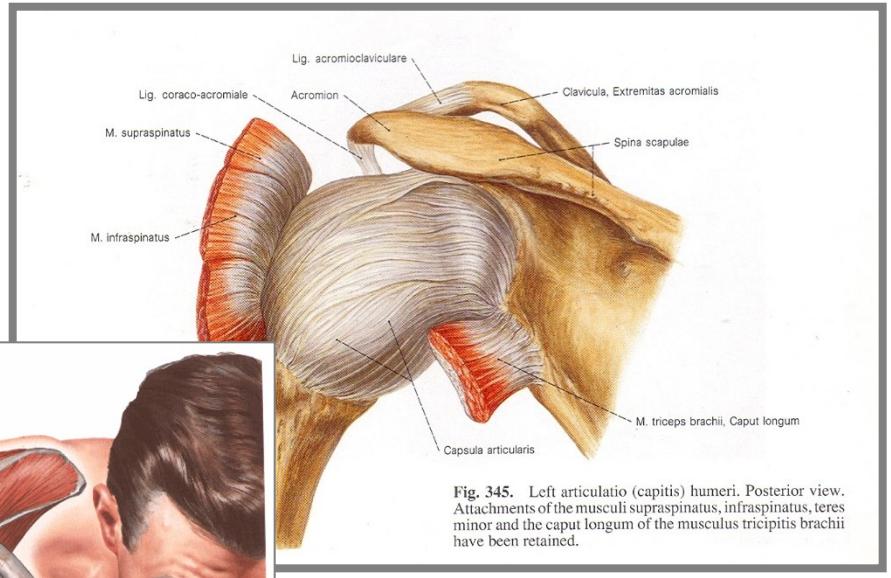
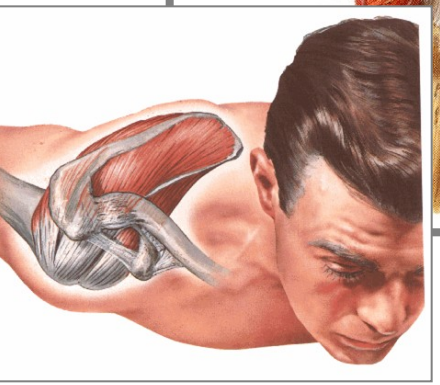
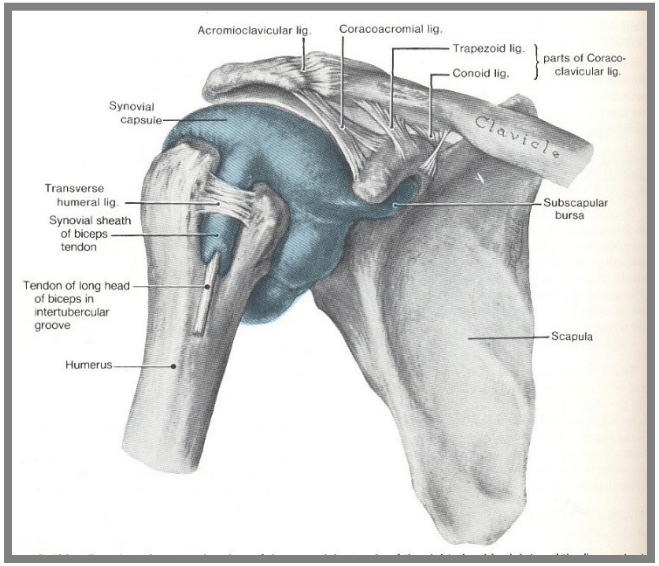


Fig. 345. Left articulatio (capitis) humeri. Posterior view. Attachments of the musculi supraspinatus, infraspinatus, teres minor and the caput longum of the musculus tricipitis brachii have been retained.

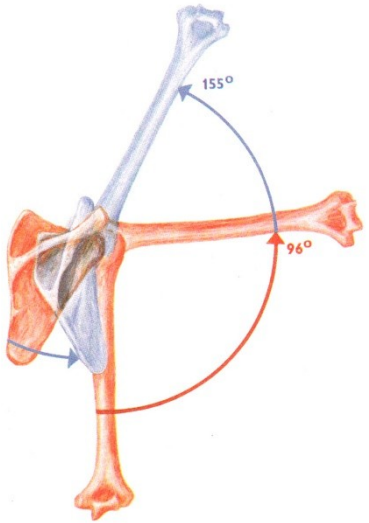


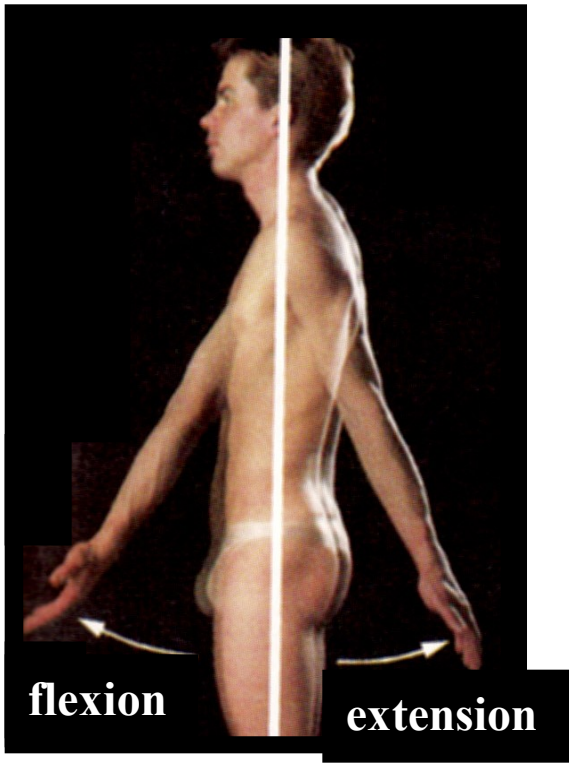


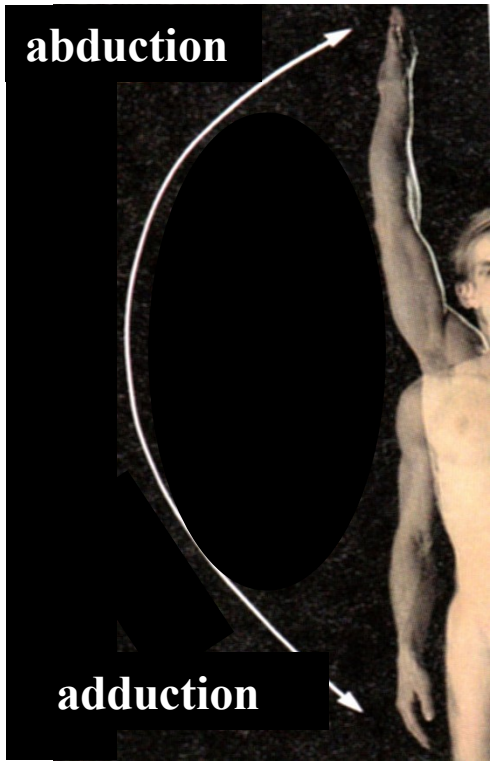
Articulatio humeri

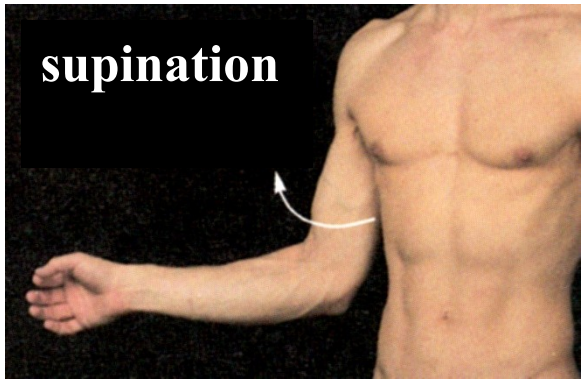
Type of joint: spheroidea – ball and socket **(arthrodia)**

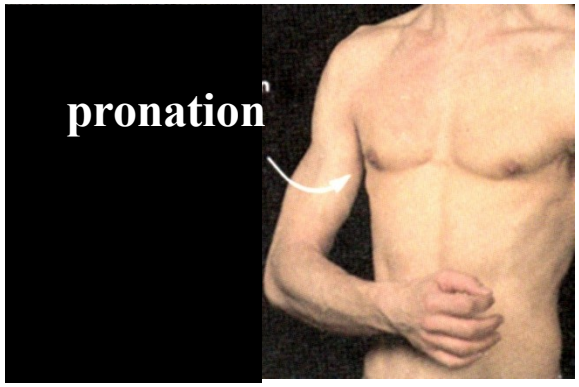
Movements: triaxial joint, to all directiones











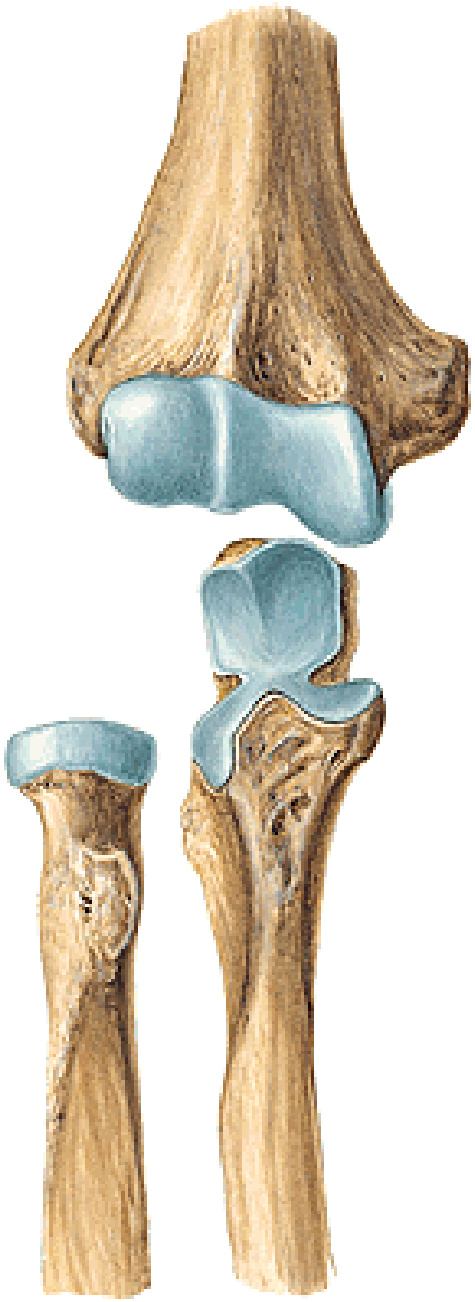
Articulatio cubiti (elbow joint)

Articulatio composita:

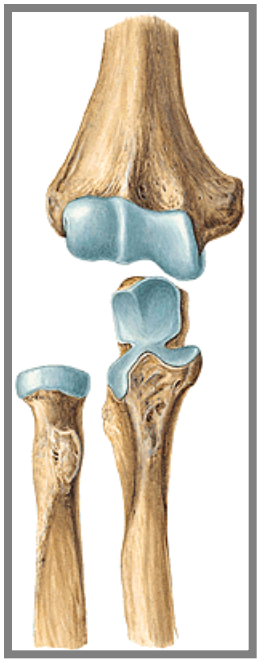
1. Articulatio humeroradialis

2. Articulatio humeroulnaris

3. Articulatio radioulnaris proximalis



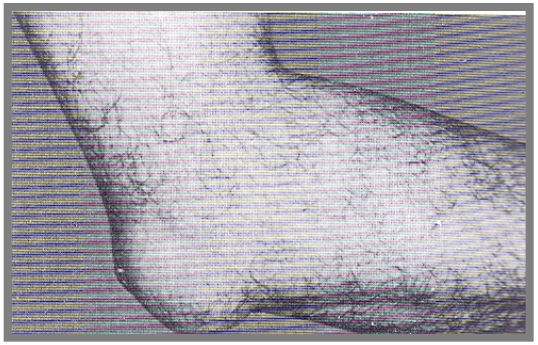
2. **Articulario cubiti** *(Elbow joint)* compound joint

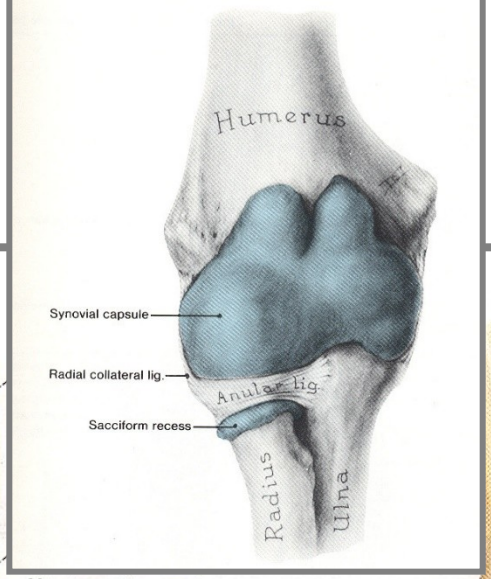


Articulatio humeroradialis *(humeroradial joint)*
Articulatio humeroulnaris *(humeroulnar joint)*
Articulatio radioulnaris proximalis *(radioulnar proximal joint)*

Articular surfaces :
Articular capsule : both epicondyli of humerus are free, all fossae of humerus are located **intracapsularly**, on the radius runs to the collum radii – recessus sacciformis.
Auxiliary facilities: ligg. collateralia rad. and uln., anulare radii
Type of joints:
Movements: flexion and extension, rotation (inner-pronation) and external rotation (supination)

Subcutaneous and subtendinous olecranon bursa.





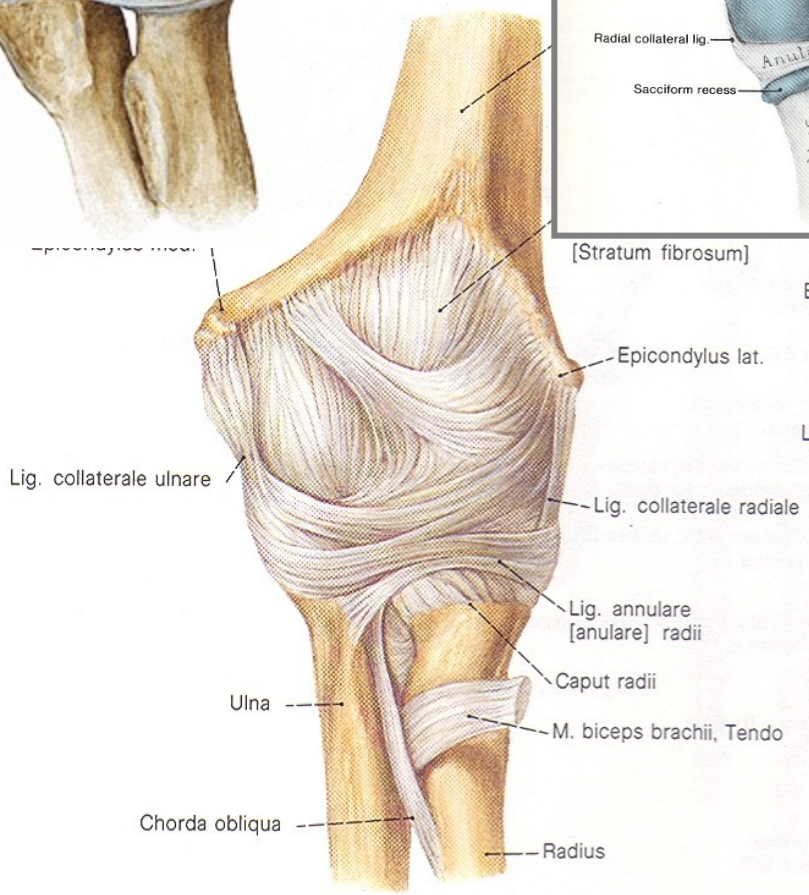


Fig. 358. The left articulatio cubiti. Anterior view.

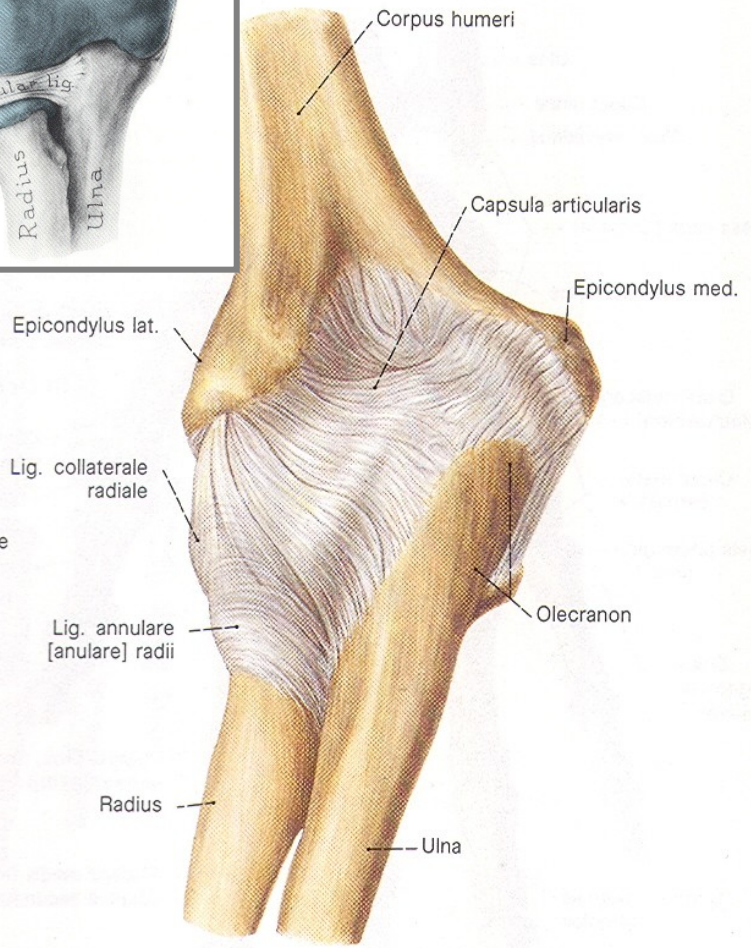
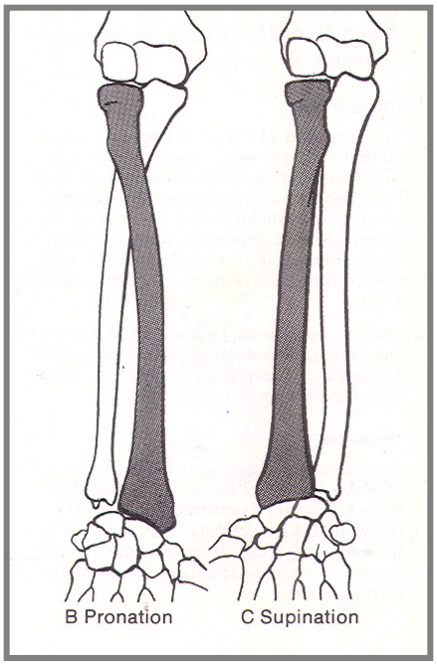


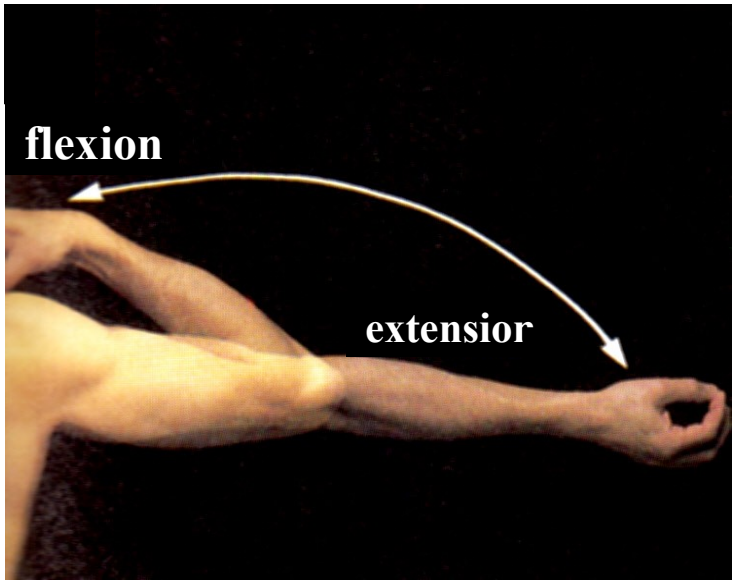
Fig. 359. The left articulatio cubiti. Posterolateral view.

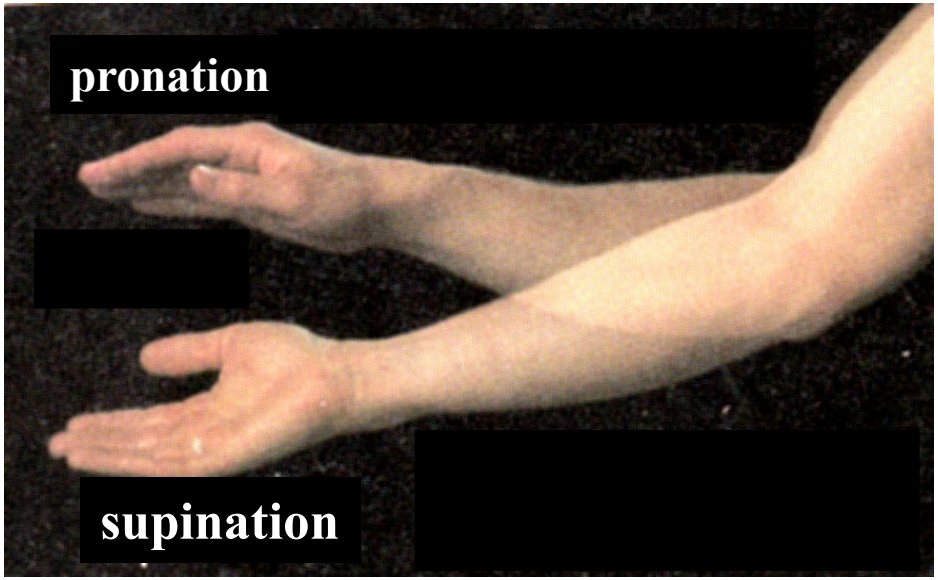
Articulatio cubiti - movements



flexion and extension (hyperextension over 180°)

pronation and supination of forearm





Used pictures come from:

Moore, K. L. (1992): Clinical oriented anatomy. Third edition. Williams&Wilkins, A Waverly Company.

Gilroy, A. M. et all. (2009): Atlas of Anatomy. Thieme New York, Stuttgart.

Putz, R. (2008):
Atlas of Human Anatomy Sobotta. Elsevier Books.

Platzer, W., Kahle, W., Leonhardt H. (1992):
Locomotor system. Georg Thieme Verlag, Stuttgart,
New York, 4th edition.

Čihák, R. (1987): Anatomie 1. Avicenum, Zdravotnické nakladatelství.