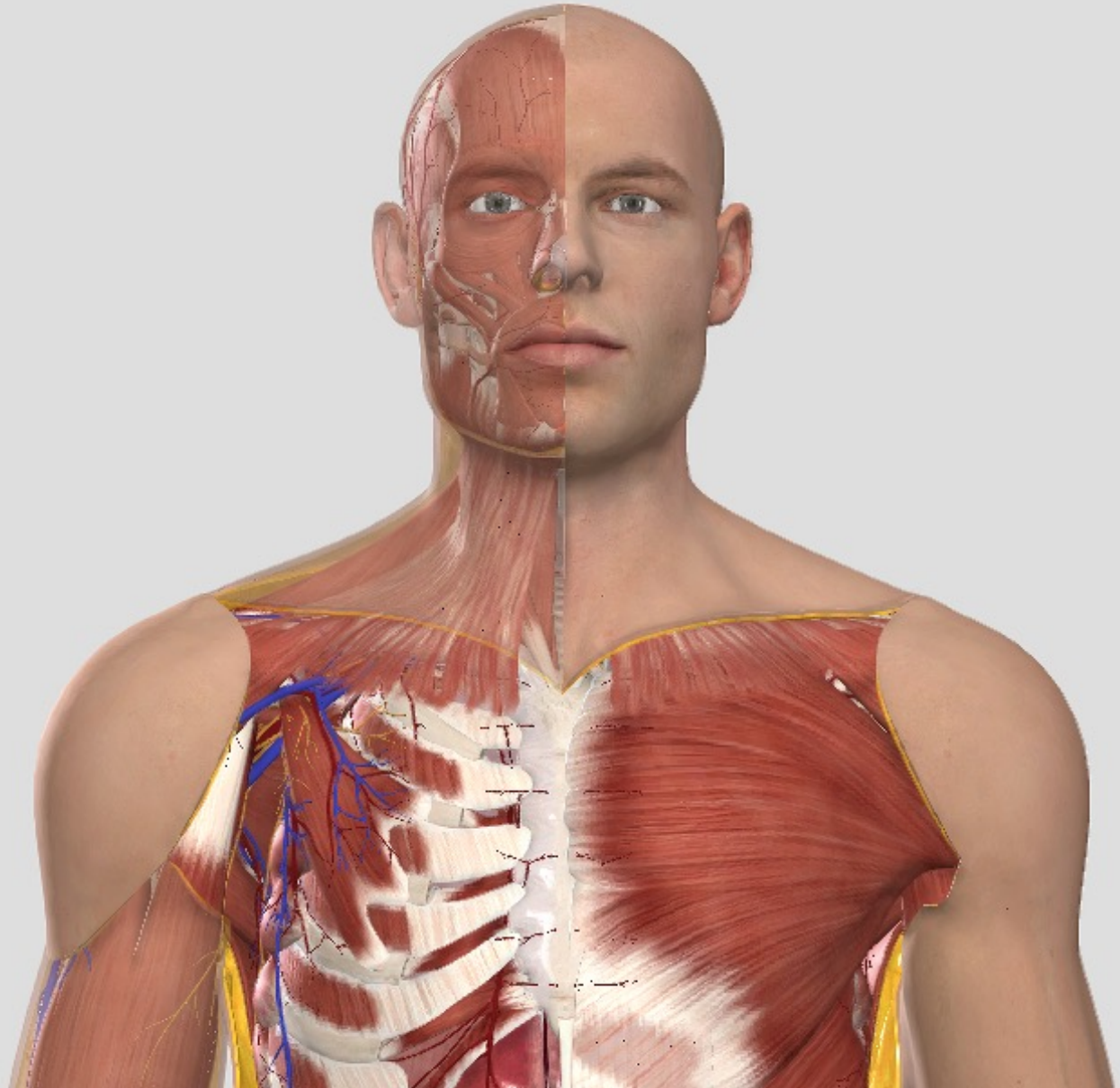
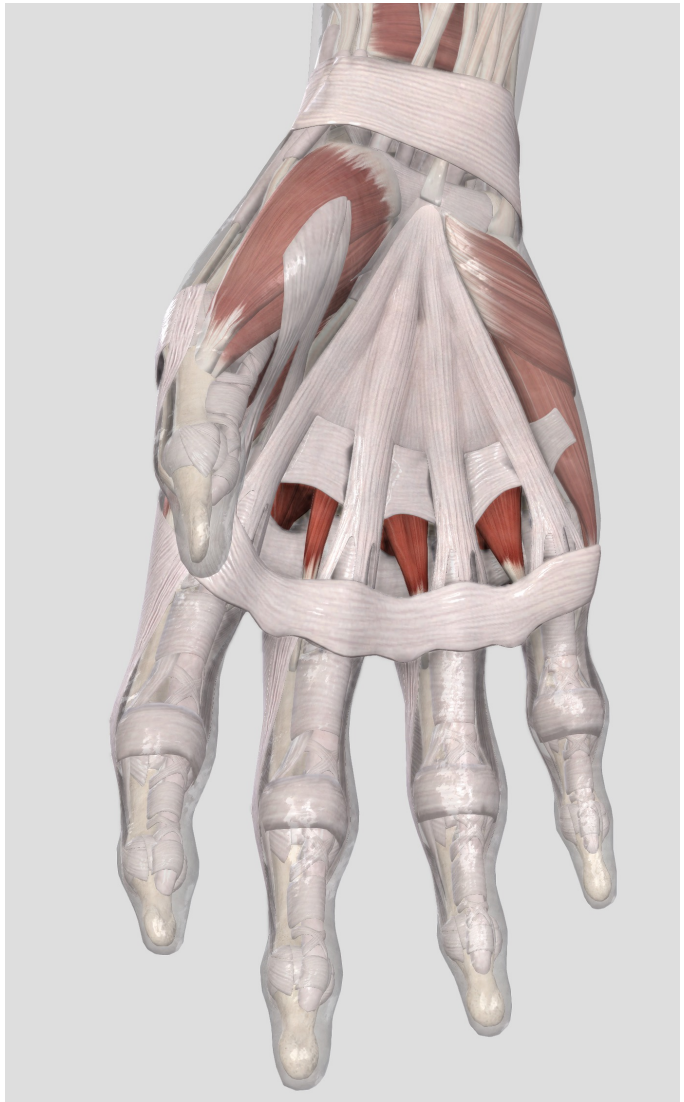
General anatomy 2.



Connective tissue

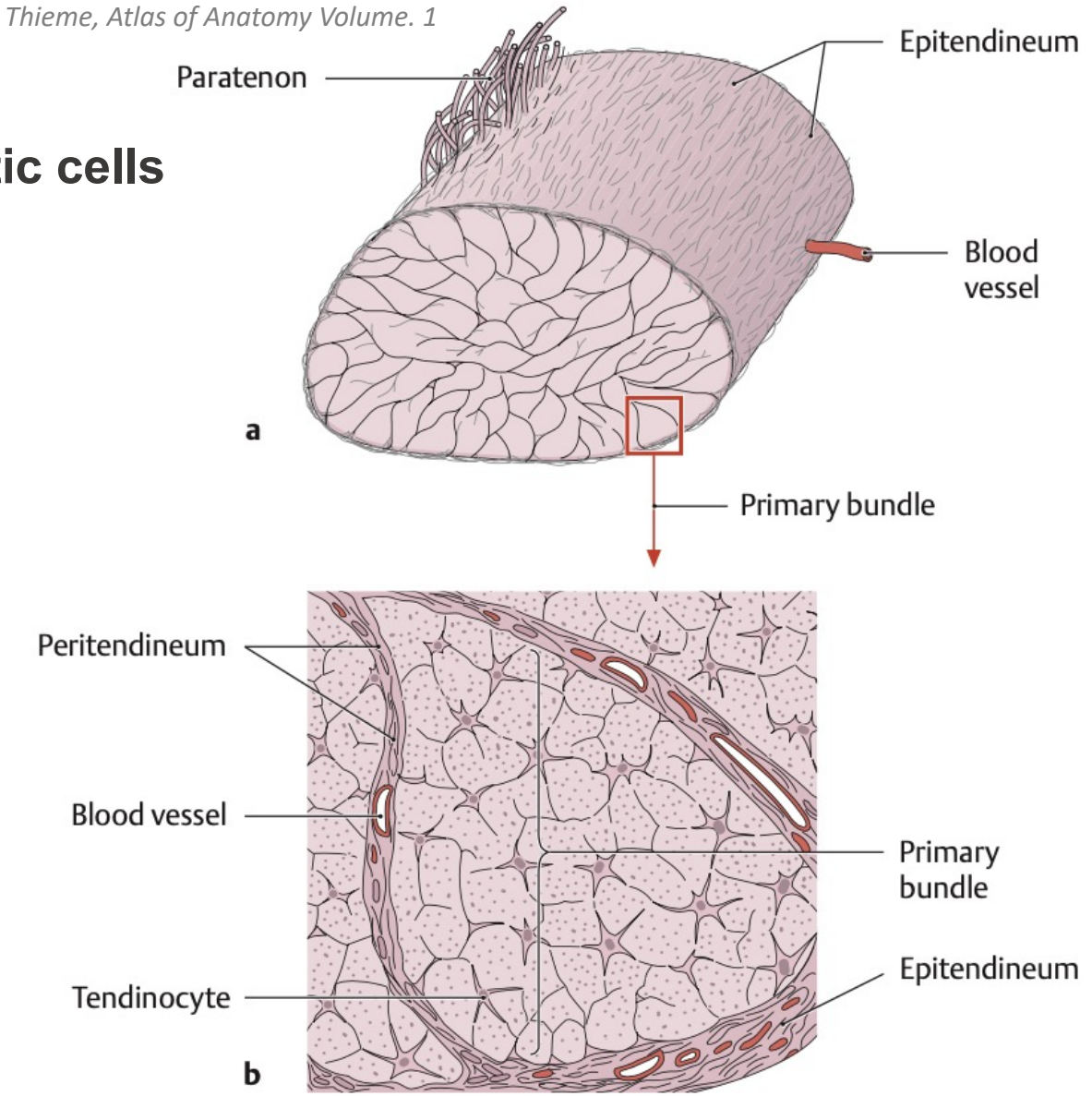
- Cells and extracellualr matrix are causing character of tissue
- Connective tissue
- Cartilage
- Bone



Connective tissue

- Collagene and elastic fibres
- cells
  - fibrocytes, histiocytes, mastocytes, plasmatic cells
- **Mezenchyma**
  - *Primitive connective tissue*
- **Gelatinous**
  - *Umbilical cord*
- **Reticular**
  - *Bone marrow*
- **Collagenous**
  - Fibrillary – loose, insterstitial
  - Fibrose – stiff – ligamenta, tenda
- **Elastic**
  - Ligamenta flava
- **Fatty**

Thieme, Atlas of Anatomy Volume. 1

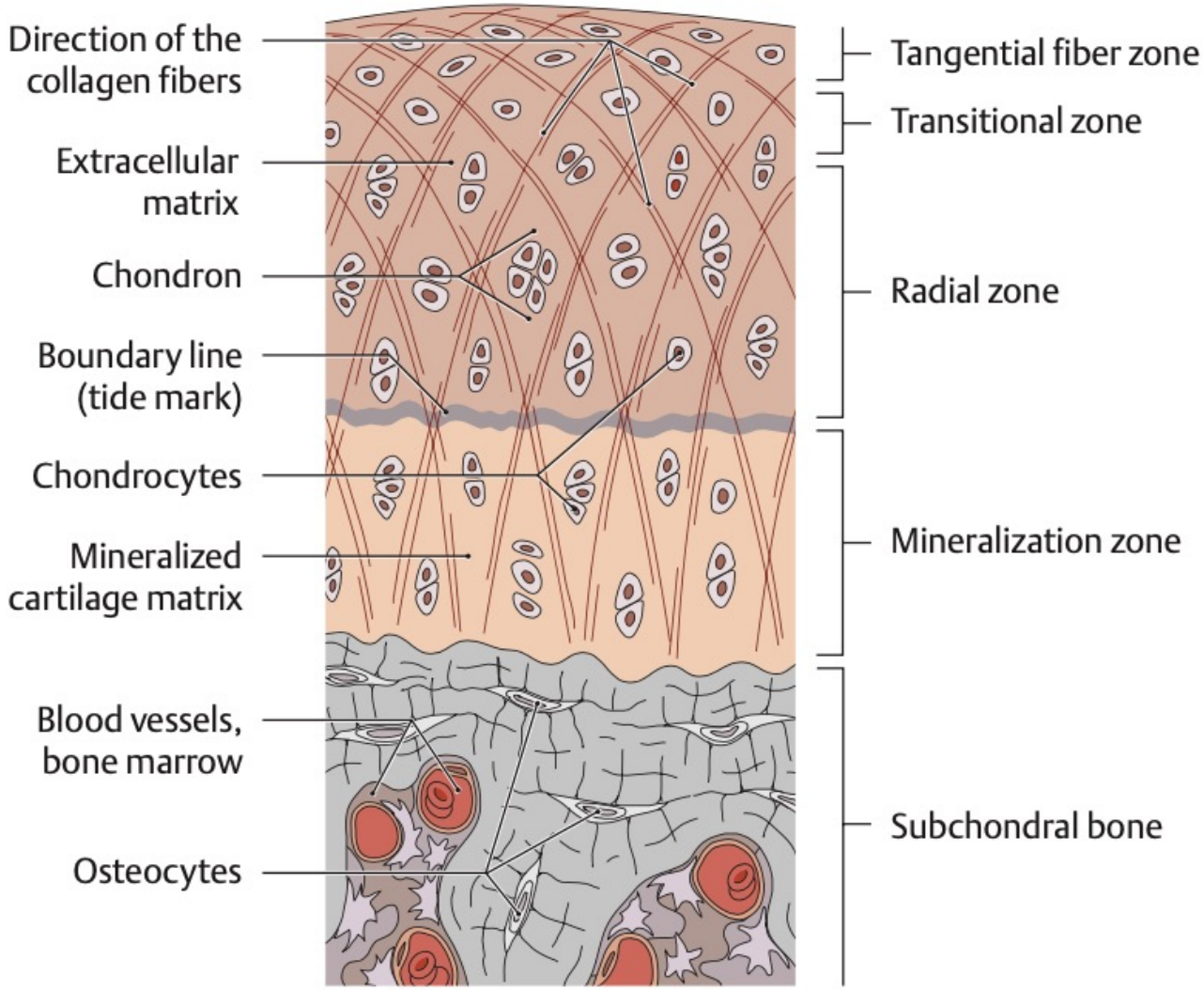


Cartilago

- **Perichondrium**
- **Fibrils**
- **Spindle fibrocytes**
- **Chondrocytes**

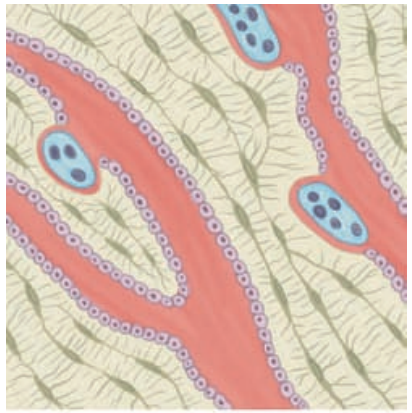
- **Cellular, parenchymatous**
  - *Embryonal, adult bat auricle*
- **Glass form – hyalinous**
  - *Masked fibrils, glossy surface*
- **Fibrous**
  - *Paltes, discs, meniscs*
- **Elastic**
  - *auricula, epiglottis*

Thieme, Atlas of Anatomy Volume. 1

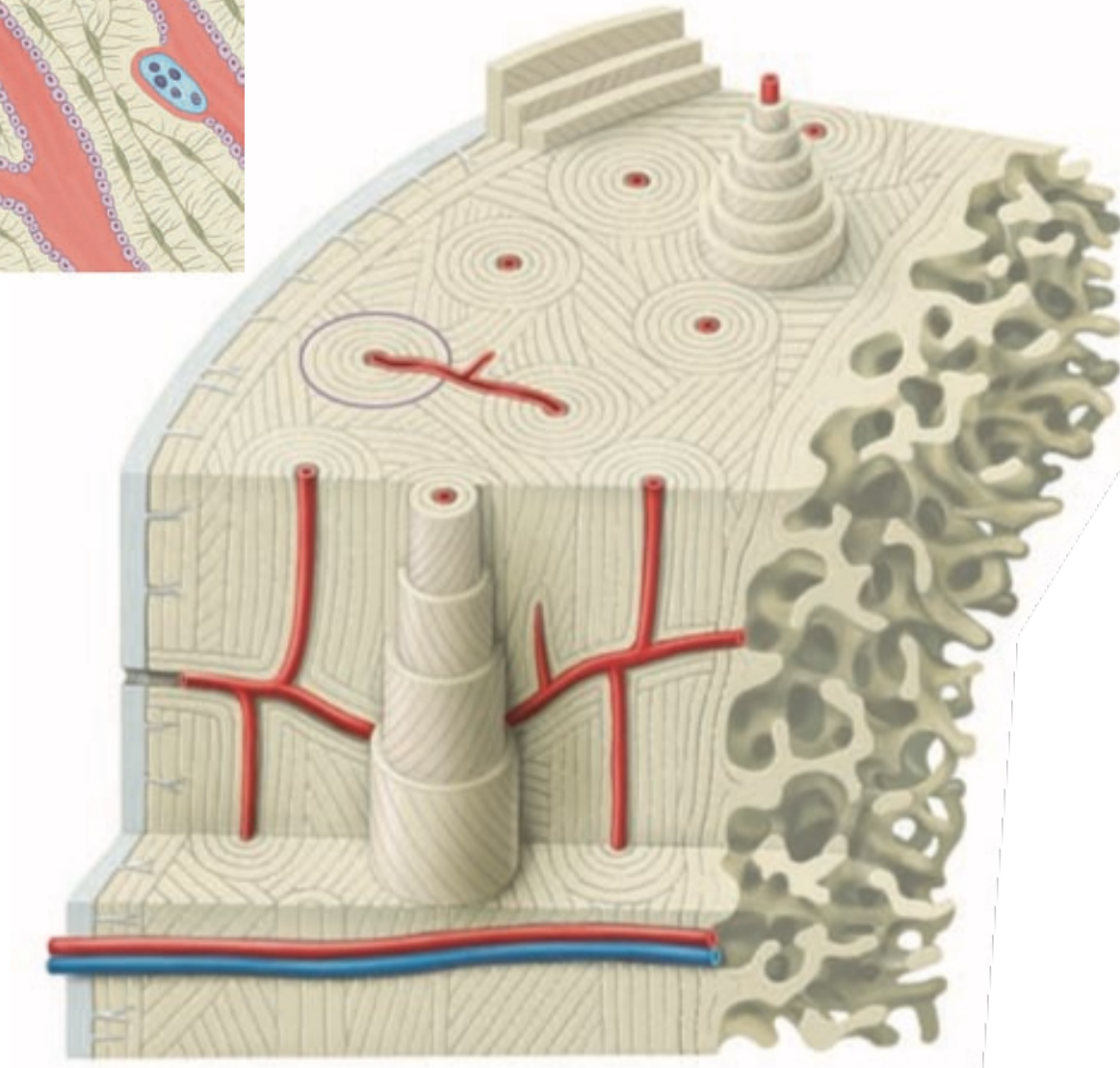


bone; os, ossium

- **Os, ossis**
- *Osteocytes, osteoblasts, osteoclasts*
- **Intercellular matrix**
- ***Anorganic part – hardness***
  - Removed by chemicals, acids, hydroxides
  - ***85% $Ca_3(HPO_4)_2$ – hydroxyapatite***
  - *10% $CaCO_3$ – calcit*
  - *5% other salts*
- ***Organic part – elasticity***
  - Removable by burning
  - ***Ossein***
  - *52% childhood*
  - *40% adulthood*
  - *30% senium*



Thieme, Atlas of Anatomy Volume. 1



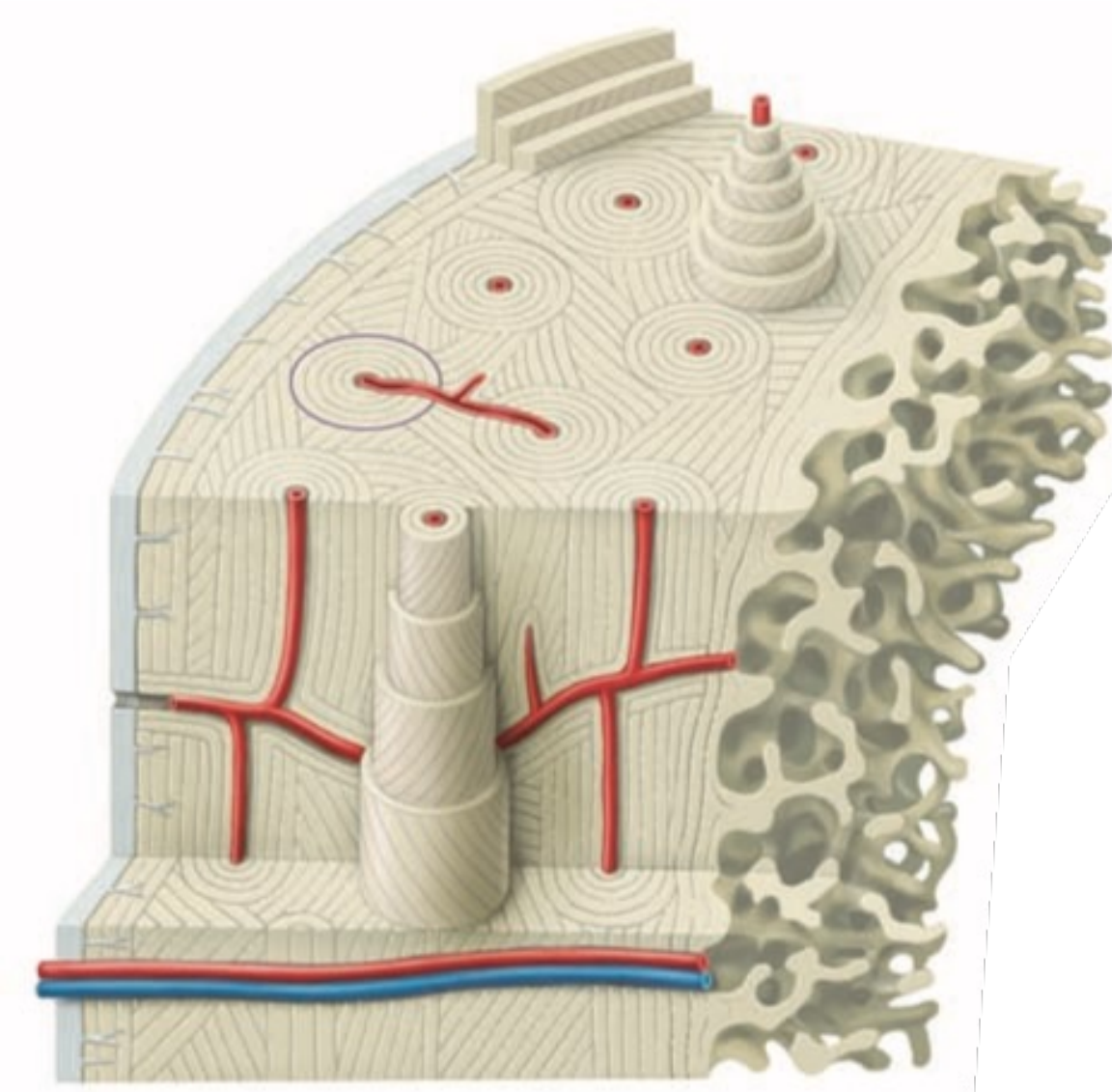
Bone structure

- Lamels
- Perpendicular orienttion
- Substantia compacta – compaq bone
- Substantia spongiosa – spongiform bone

- **Periosteum**

- **Osteon**
- Havers channel
- Volkmann channel
- Surface lamels – outer, inner
- Intersticial lamels

Thieme, Atlas of Anatomy Volume. 1



Bone structure

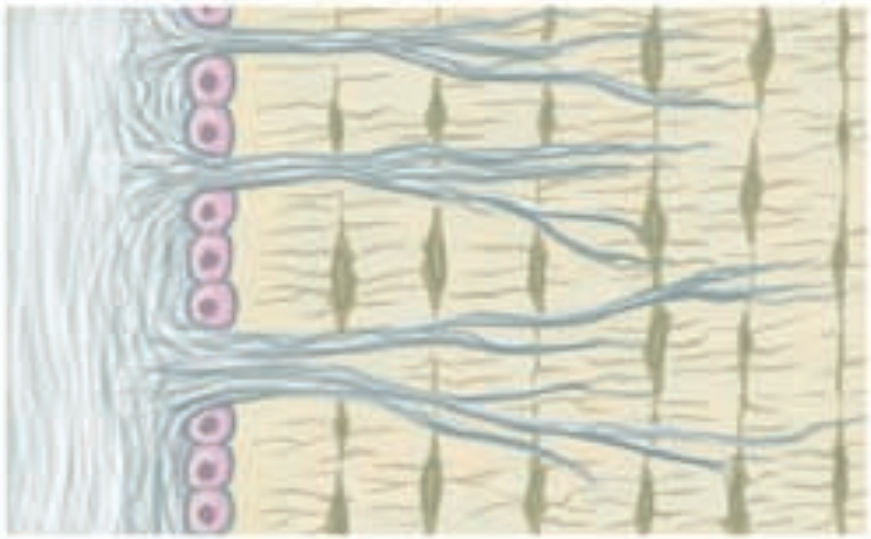
- **Substantia compacta**
- **Substantia spongiosa**
- **Cavum medullare**
- ***Medulla ossium***
  - ***rubra* – blood forming**
    - *Axial skeleton, sternum*
    - *STERNAL PUNCTURE*
  - ***lutea* – *fatty – tubular bones***
  - ***grissea* – *senile fibrous changes***
- **Periosteum**
  - **Superficial fibrous membrane**
  - **Stiff in childhood**
  - *Subperiostal fracture in children*

Architecture

- **Substantia compacta**
- **Substantia spongiosa**
- ***Pressure, flexion***
- *Atrofia*
- *Decreased mechanical resistance*

Periosteum

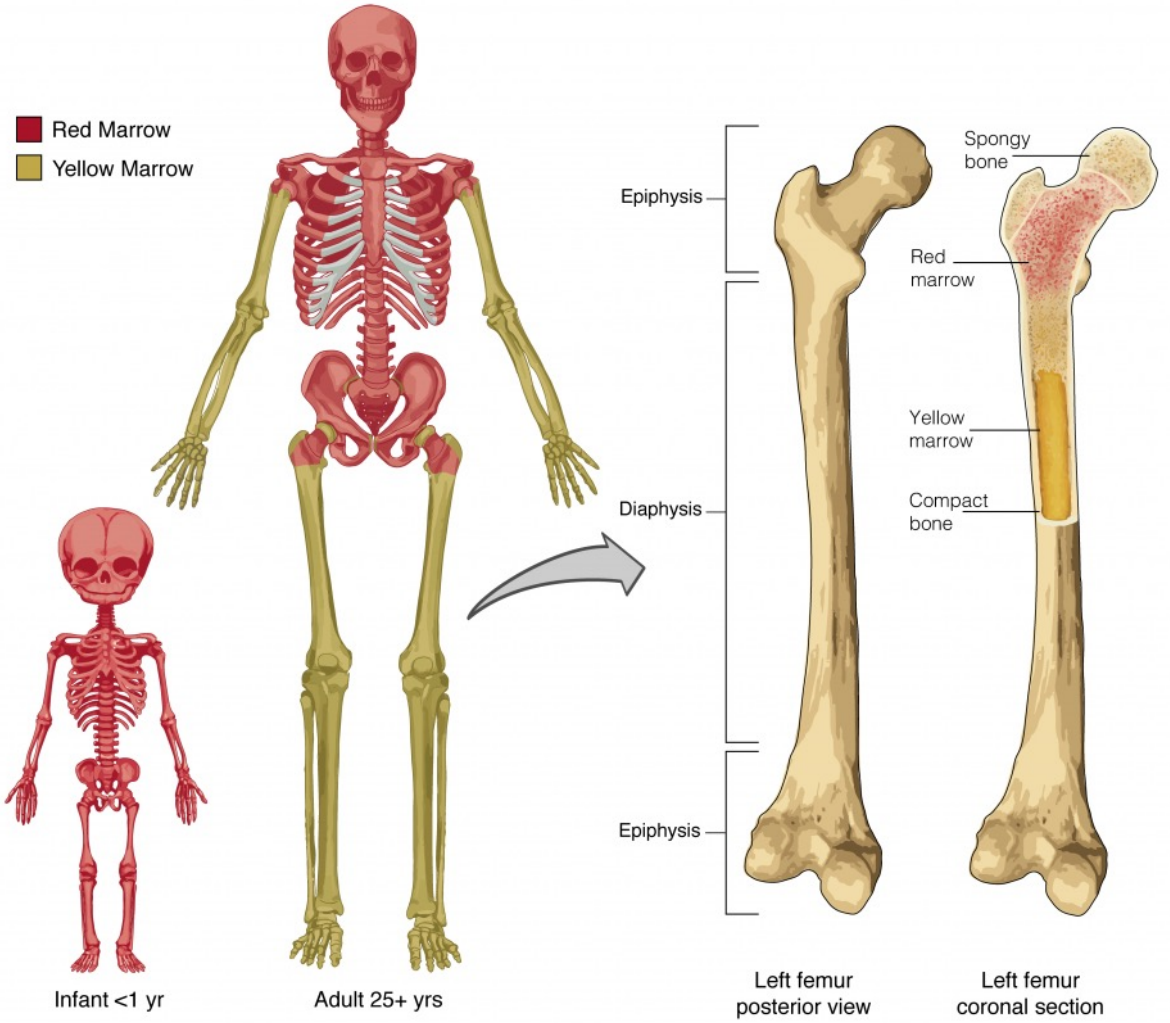
- **Stratum fibrosum**
- ***Cambium***
- ***Sharpey fibers***
- *Anchored between osteocytes*



Bone marrow – medulla ossium

- Blood building tissue
  - Cellular precursors of blood
  - megakaryocytes
  - sinusoids
  - *Red, yellow, grey*
- newborn
- adult
- activation
  -
- Extramedullary hemopoesis
  - liver
  - spleen
  - retroperitoneum

https://open.oregonstate.education/aandp/chapter/6-1-the-functions-of-the-skeletal-system/



Bone marrow – medulla ossium

Aktivovaná červená kostní dřeň u dospělého – ^{18}F-FDG-PET

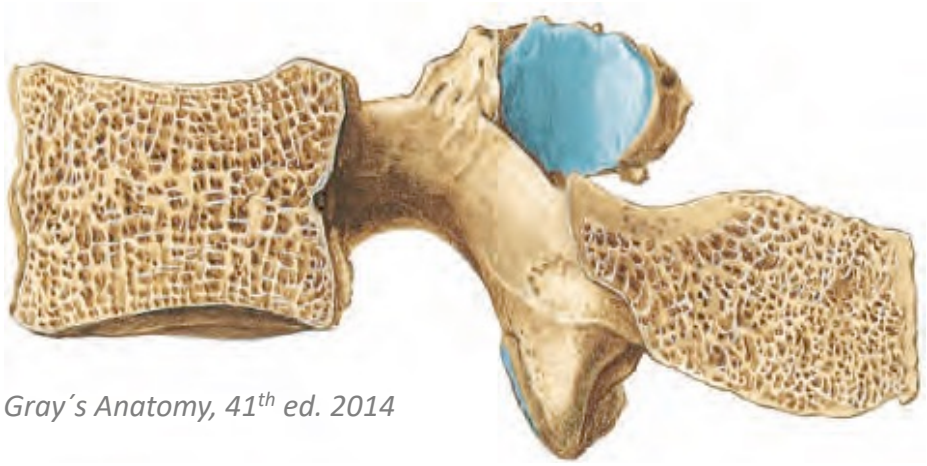
Aktivní červená kostní dřeň u adolescenta – ^{18}F-FLT-PET

Bone parts

- **epiphysis proximalis, distalis**
  - *Joint ending*
- **physis proximalis, distalis**
  - *Growing plate*
- **metaphysis proximalis, distalis**
  - *Widening at the diapohysis ending*
- **diaphysis – corpus ossis**
  - *Bone body*
- **apophysis**
  - *Independently ossified processes*
- **physis apophyseos**
  - *Apophyseal growing plate*

Bone shapes

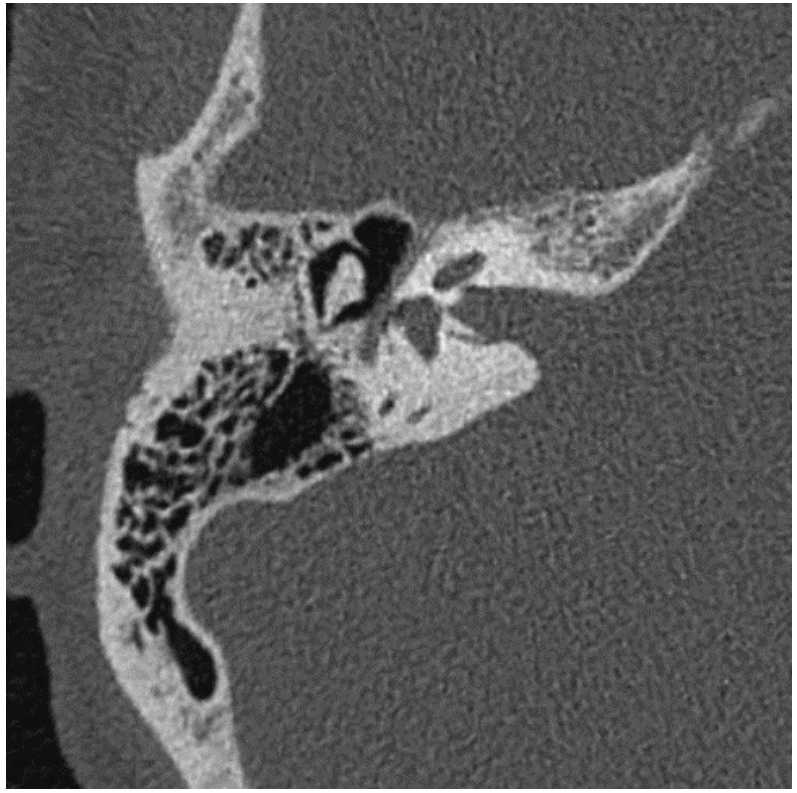
- Long bones
- Short bones – carpus, tarsus, vertebrae
- Flat bones– scapula, neurocranium
  - Skul – lamina externa, diploe, lamina interna
- Irregular bones– splanchnocranium
- Sesamoid bones – patella, os pisiforme
- Pneumatized bones

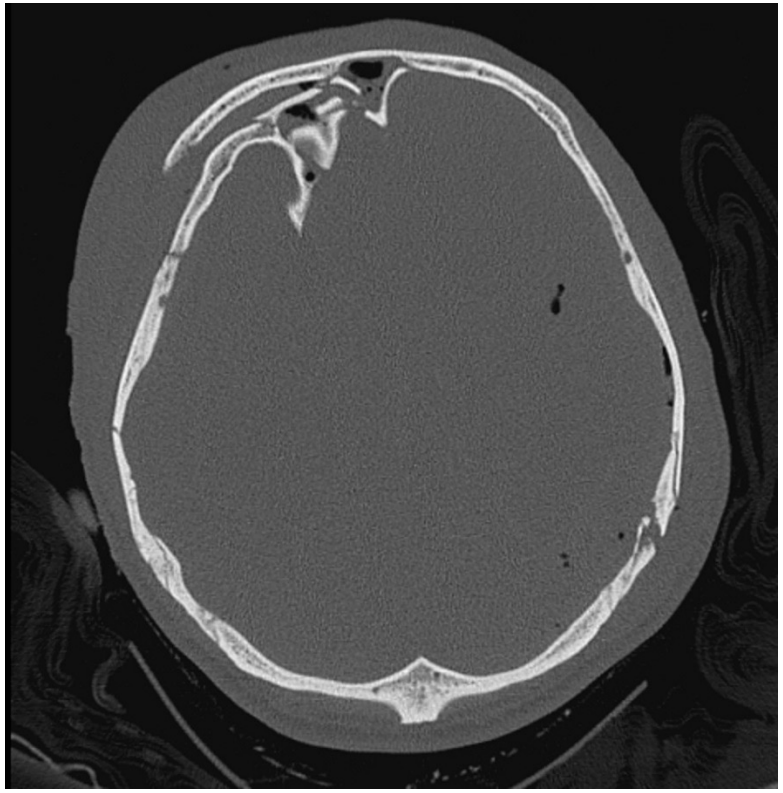


Gray´s Anatomy, 41th ed. 2014

Ossa pneumatica

- Pneumatized bones
- The mucosa is growing into the bone and forming air-filled cavities
- Processus mastoideus, sphenoid, frontal, ethmoid bones, maxilla





Development and growth

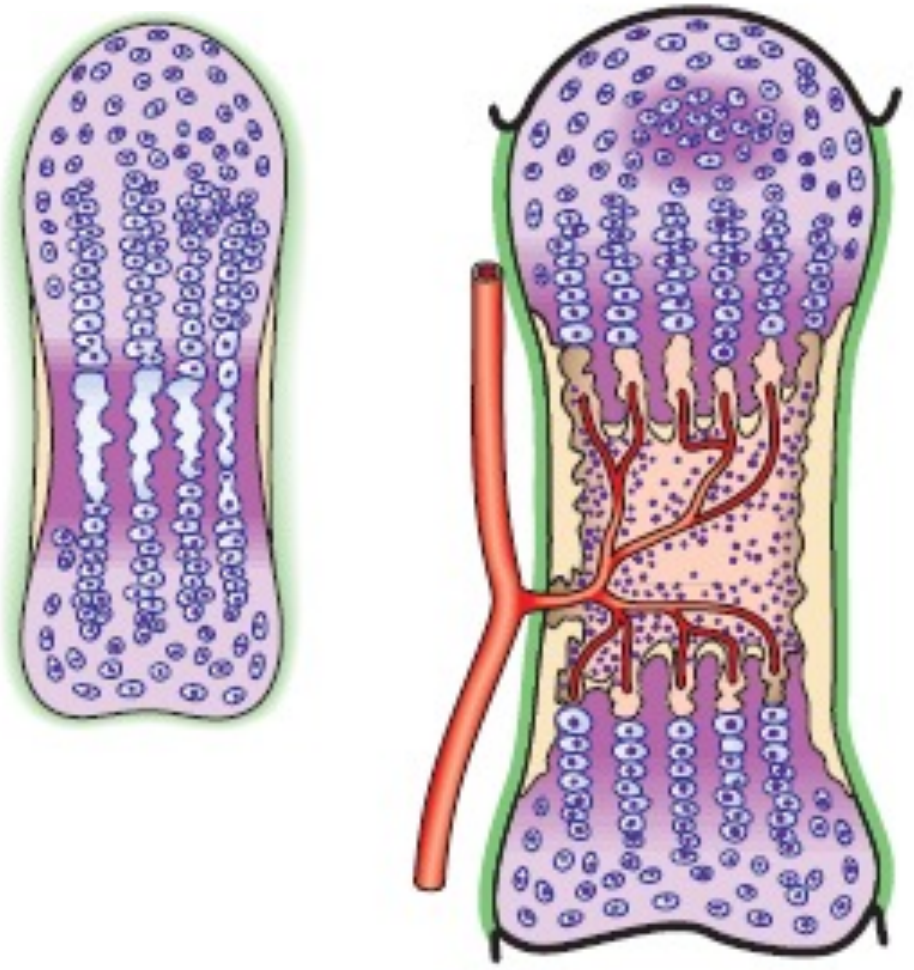
- **Desmogenic ossification**
- *Fibrous model*
- *Flat skul bones of neurocranium*
- *Clavicula*

- **Chondrogenic ossification**
- *Cartiliginous model*
- *Perichondral – on surface*
- *Enchondral - inside*

Ossification 1. stage

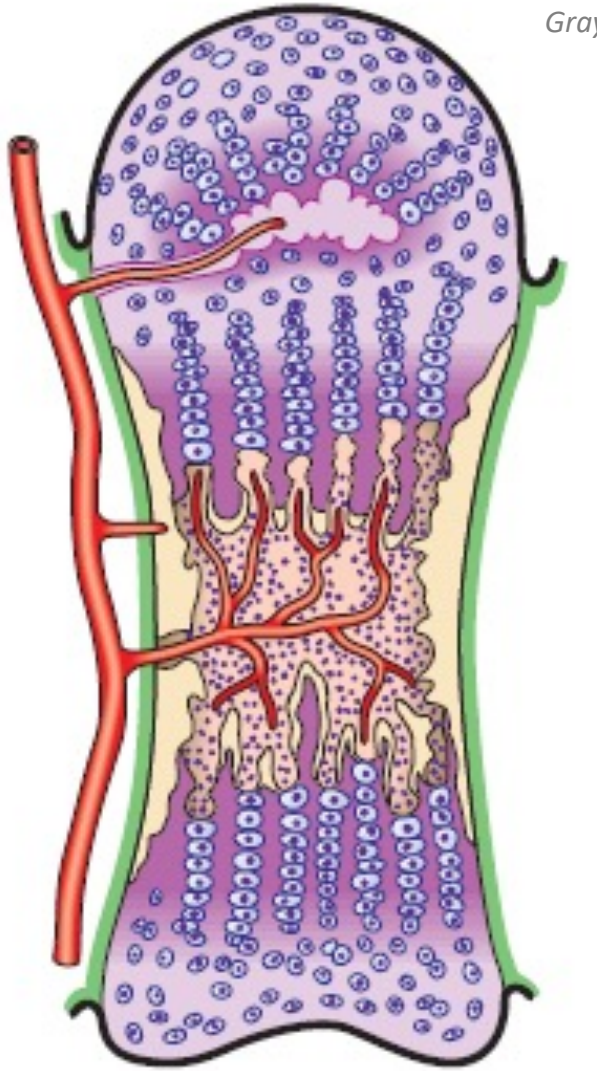
- Thing ring is forming on the surface of the model
- Spreading to the epiphyses
- Perichondral bone
- Periost - next lamella
- Vessels growing into the cartiliginous model
- Vessels causing the cartilage widening
- Bone cavity is created

Gray´s Anatomy, 41th ed. 2014



Ossification 2. stage

- The development of the diaphysis
- Periosteal bone
- From cavity enchondral ossification
- Endosteal forming
  - After creation of endosteL lamella
- Epiphyses
- Ossification nucleus
- Further enchondral ossification

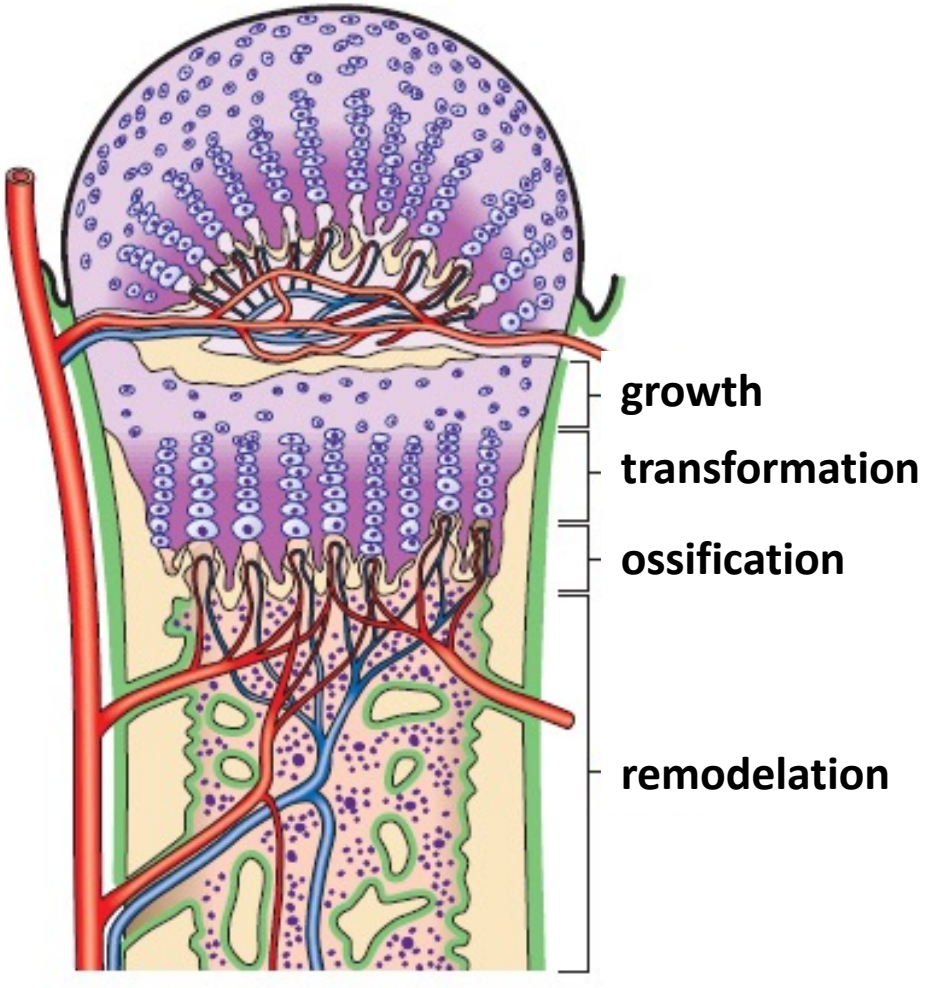


Gray´s Anatomy, 41th ed. 2014

Ossification 3. stage

- Joint cartilage
- Epiphyseal cartilage - growing pla
- Diaphysis
  - Enchondral bone
  - Endostal bone
  - Perichondral bone
  - Periosteal bone
- Epiphysis
  - Enchondral bone

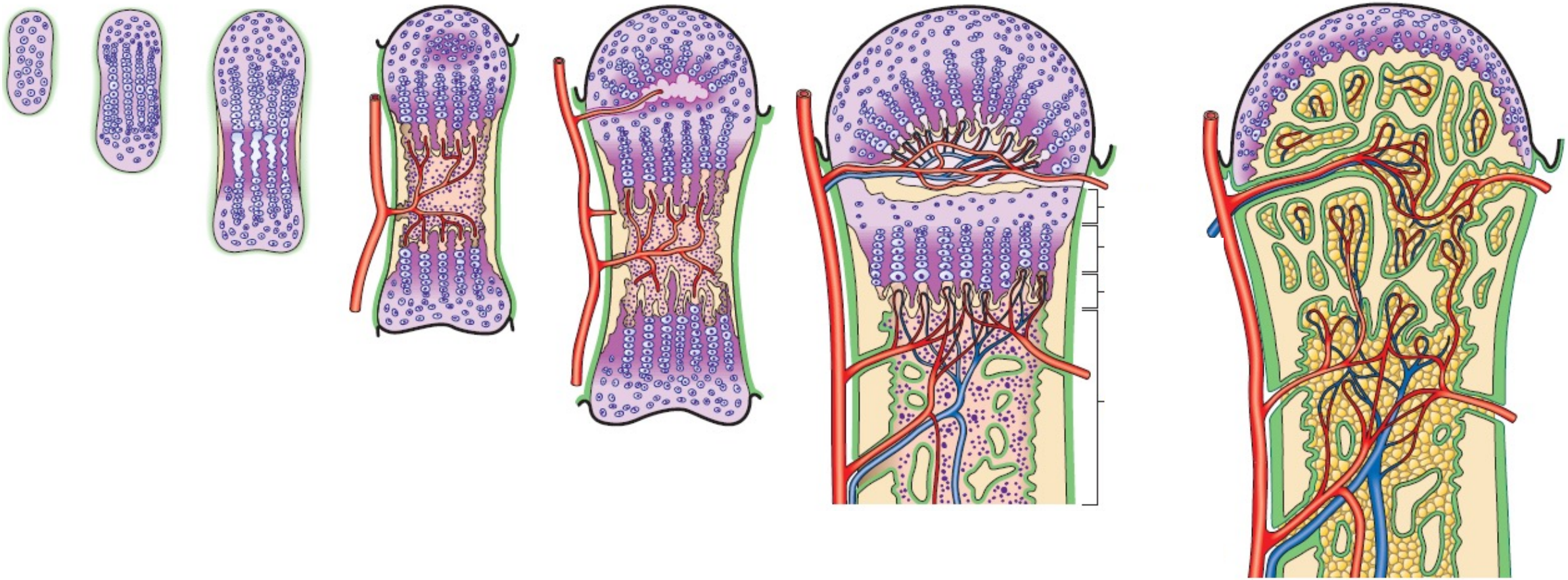
Gray´s Anatomy, 41th ed. 2014



- Only joint and epiphyseal cartilage remained from cartilagenous model

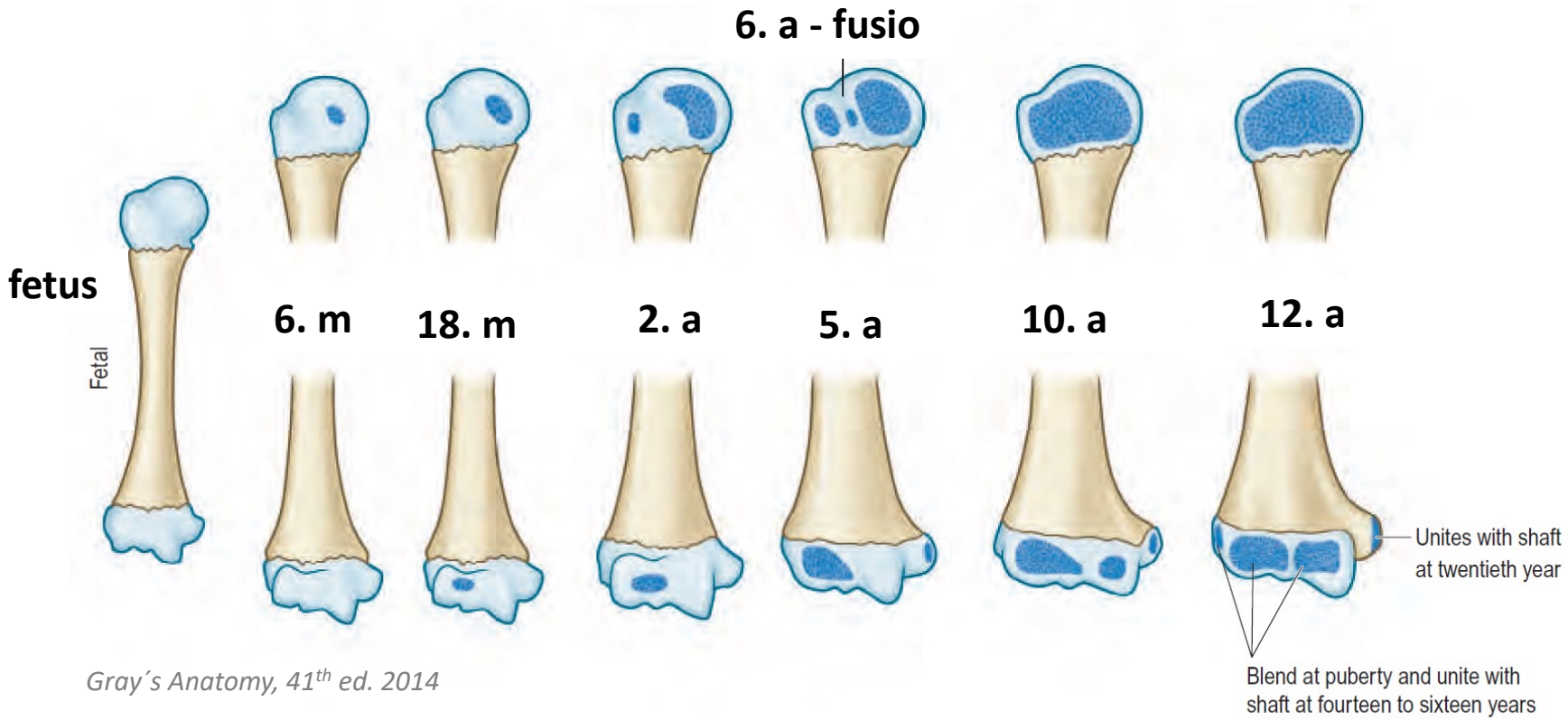
Ossification

Gray´s Anatomy, 41th ed. 2014



Ossification nuclei

- **Calendar age and hormonal status**
- **Skeletal age**
- *Adrenogenital sy - acceleration*
- *Hypogonadismus – slow-down*

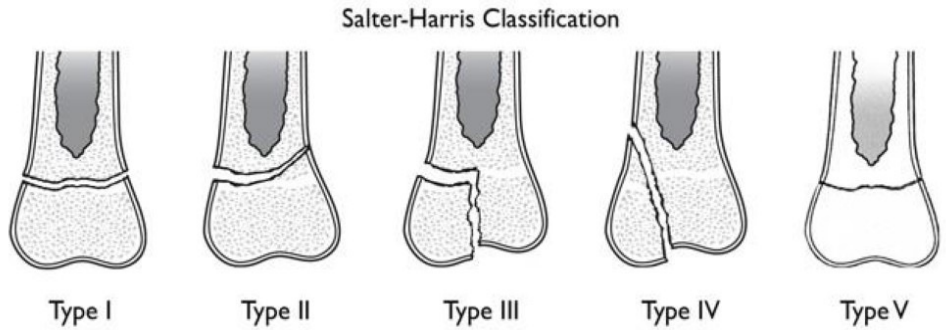


Gray´s Anatomy, 41th ed. 2014

Bone age

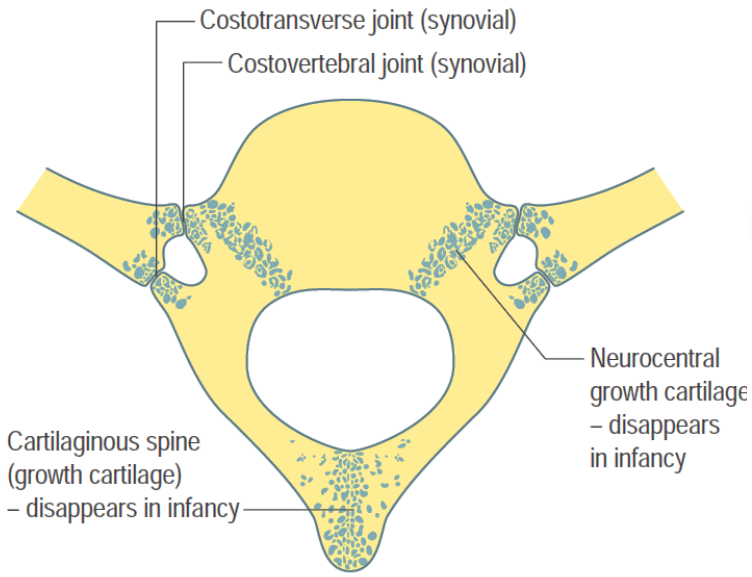
- Seriál development of nuclei related to age
- *Fastened – pubertas praecox*
- *Slow down - hypogonadism*

Growing plate

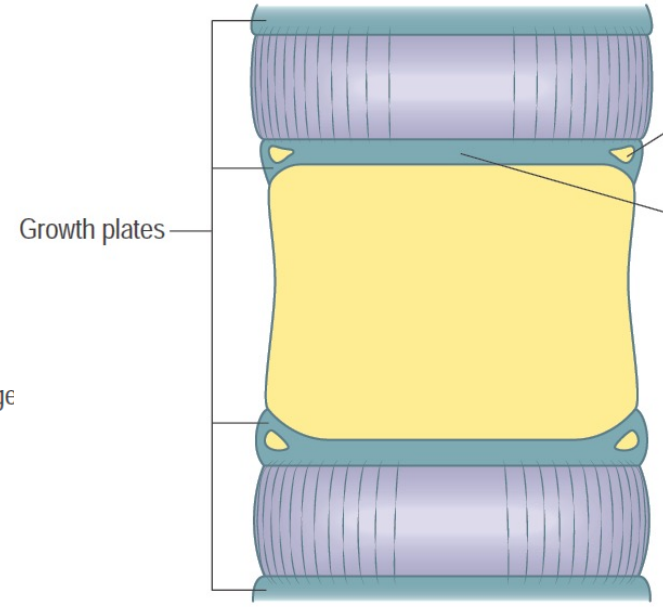


Vertebral ossification

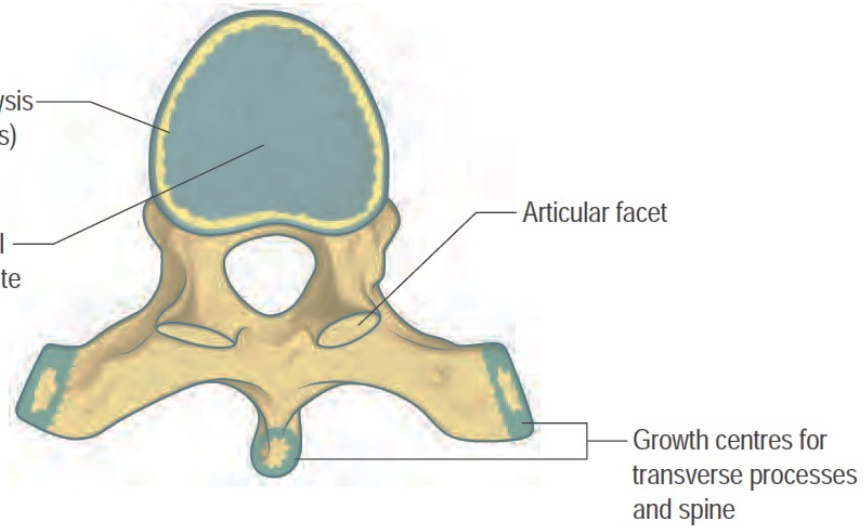
- Corpus vertebrale – neurocentral cartilage - epiphysis circularis
- Arcus vertebrae
- Processus vertebrales - cart. proc. transversus, spinosus, articularis



Bony vertebra with cartilaginous growth region

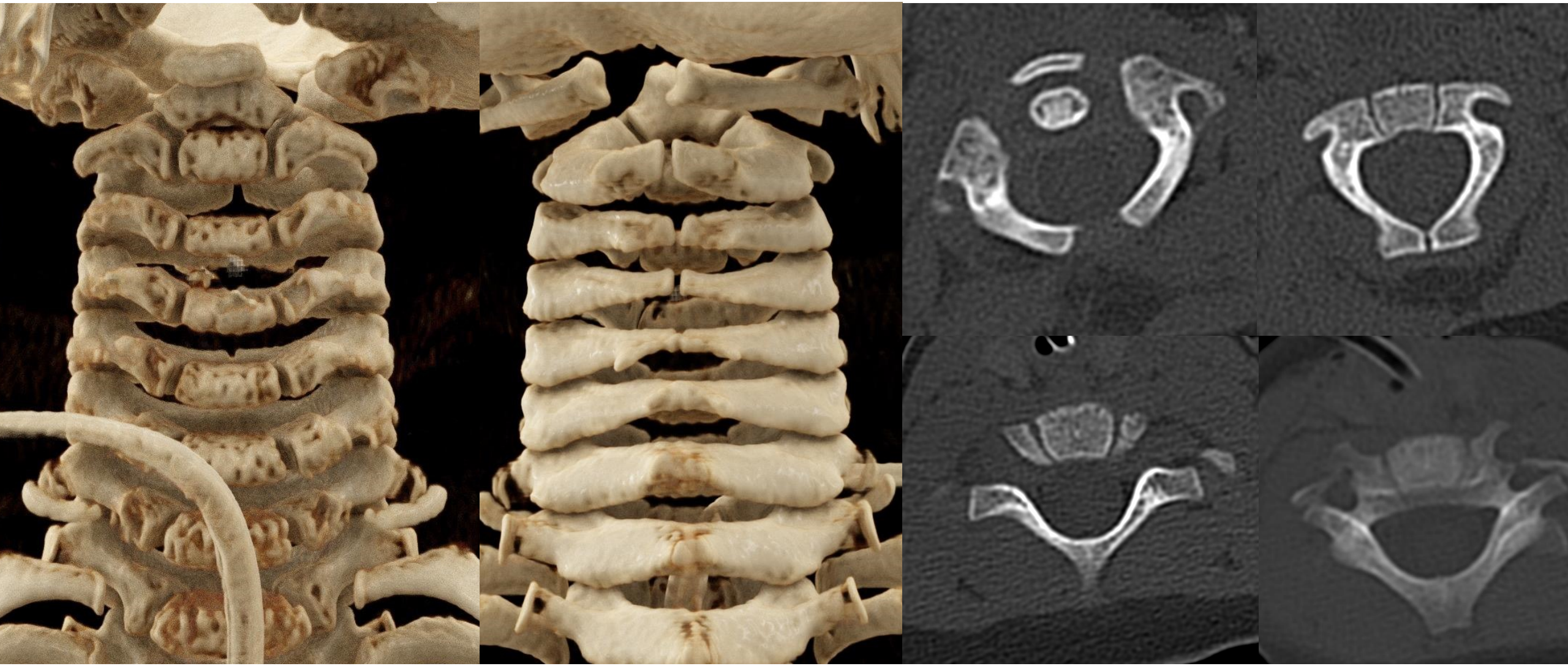


2 – Adolescence



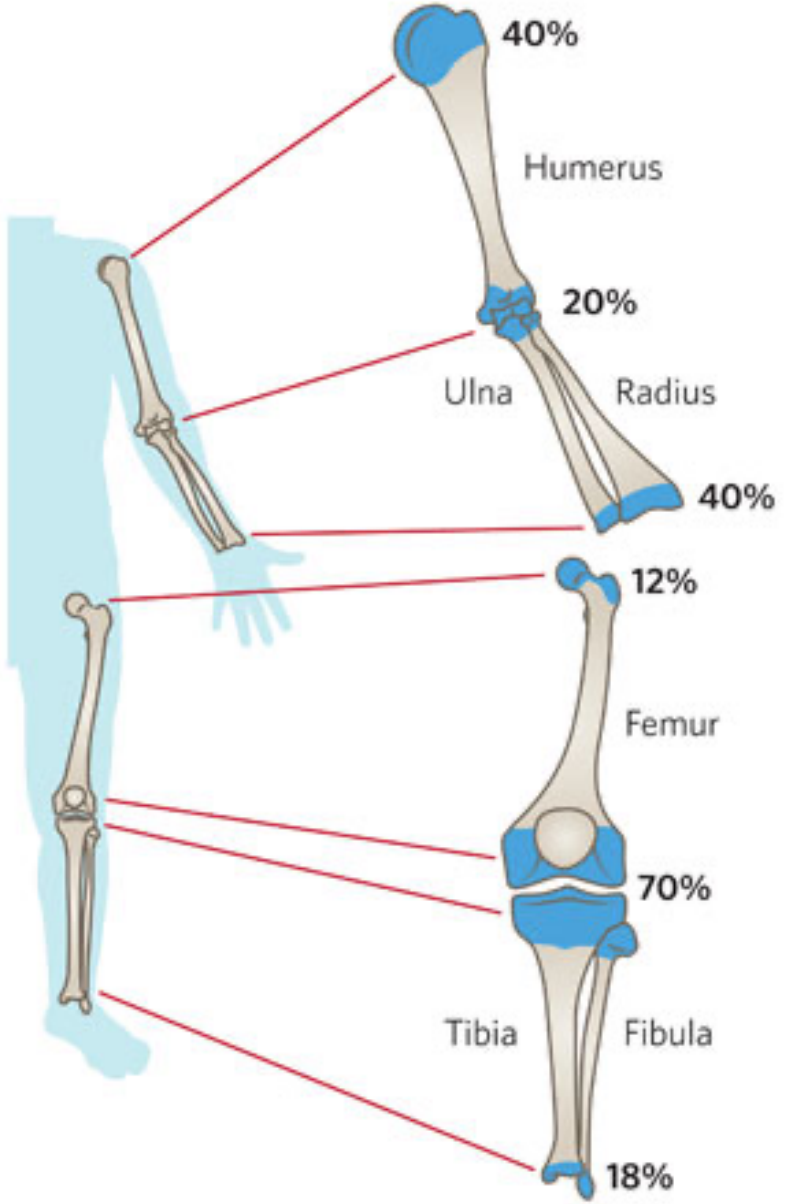
3 – Adolescence

Vertebral ossification



Growth and remodelling

- **Prolongation**
  - In growing plates
  - After occlusion - no prolongation
- **Widening**
  - On the surface – APOSITION
  - Removal in cavity – RESRPTION
- **Proximal and distal growing plates**
  - Not the same activity
  - Proximal more active in humerus
  - Distal more active in femur



Remodelling

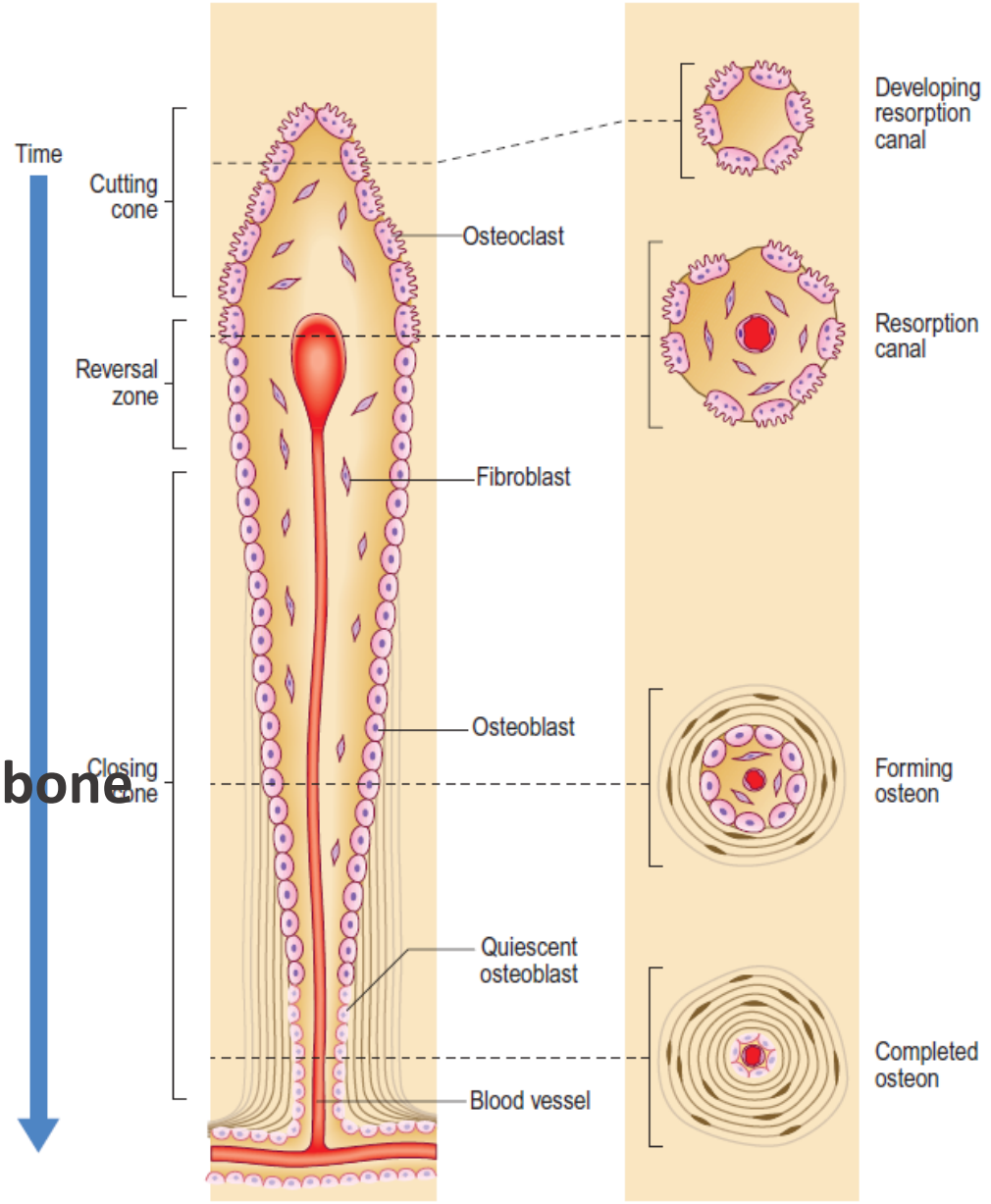
- **Remodellation of the bone tissue**

Under hormonal stimulation

Weight bearing stimulation

Physical activity stimulation

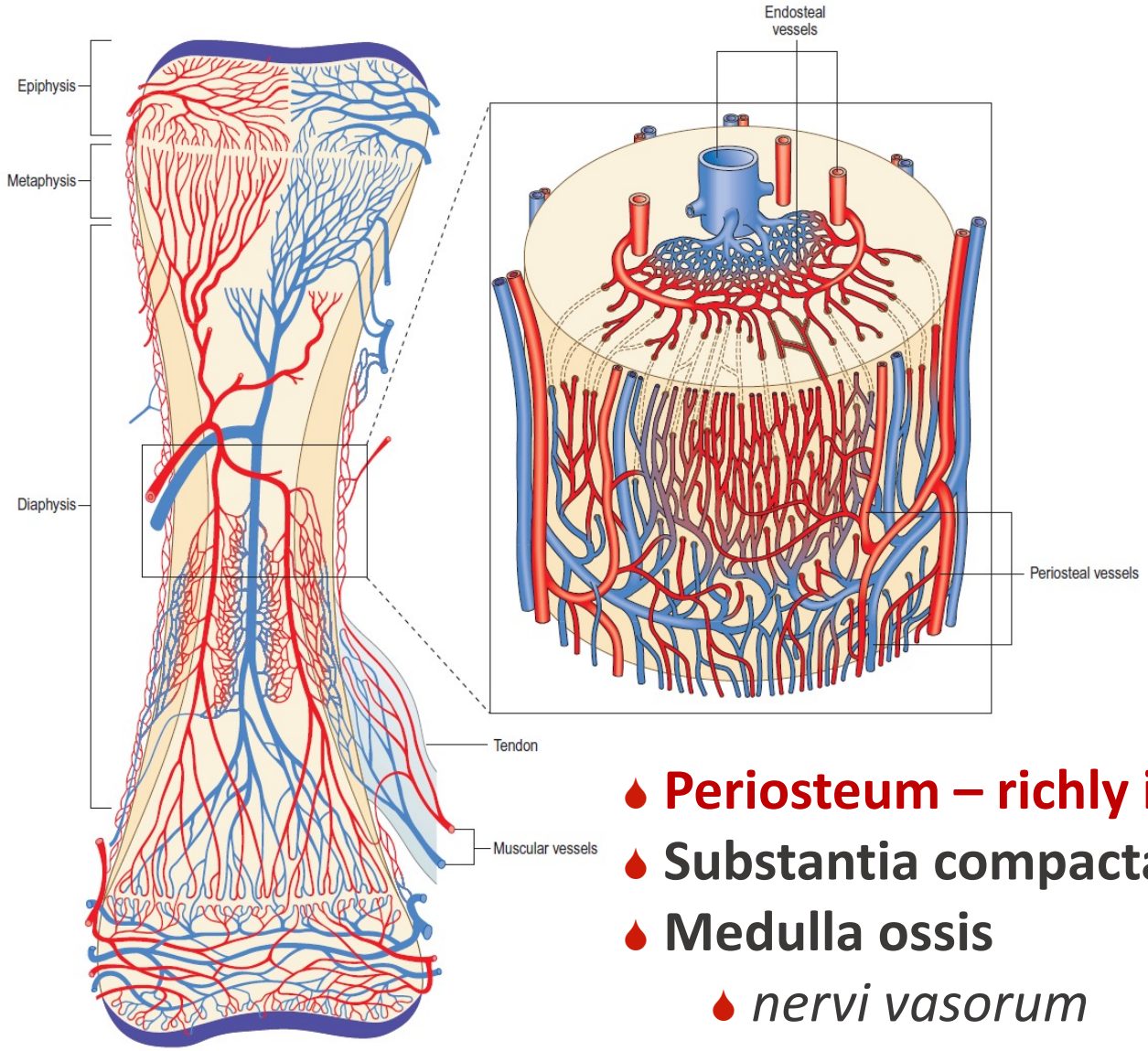
- **Never ending**
  - **Osteoclasts - bone removal**
  - *Fibroblasts - forming collagene fibers*
  - **Osteoblasts - forming osteoid non-mineralized bone**
  - **Mineralization**
  - **Completed osteon**



Gray´s Anatomy, 41th ed. 2014

Vascular suply and innervation

- **Splitted teritoria during development, than fused**
- **A. nutricia**
- **Aa. corticales**
- **Aa metaphyseales**
- **Aa. apophyseales**
- **Aa. epiphyseales**

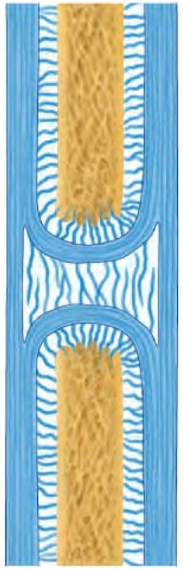


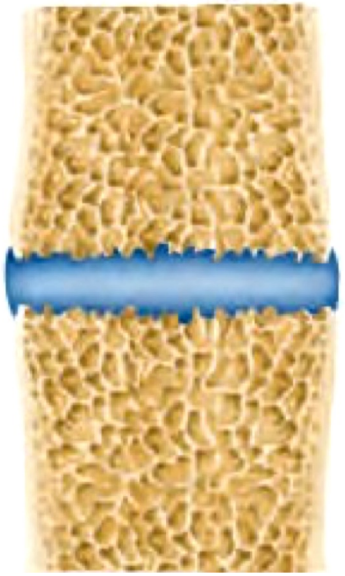
Gray´s Anatomy, 41th ed. 2014

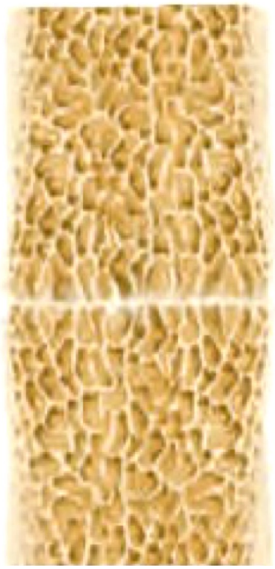
- **Periosteum – richly innervated**
- **Substantia compacta**
- **Medulla ossis**
  - *nervi vasorum*

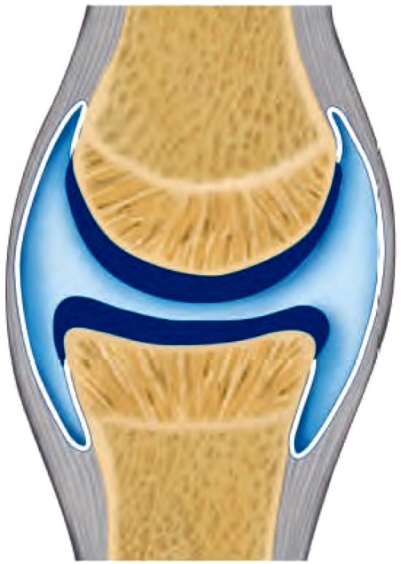
Bone junctures - connections

- **Continual – in continuitate – synarthrosis**
  - Fibrous connective tissue – SYNDESMOSIS – skull
  - Cartilage – SYNCHONDROSIS – symphysis pubis
  - Bone – SYNOSTOSIS – sacral bone
- **In touch – in contiquitate – diarthrosis**





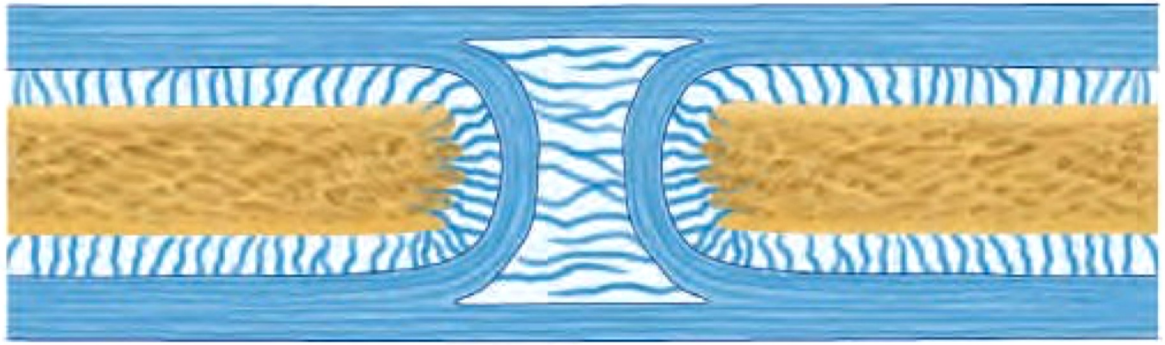


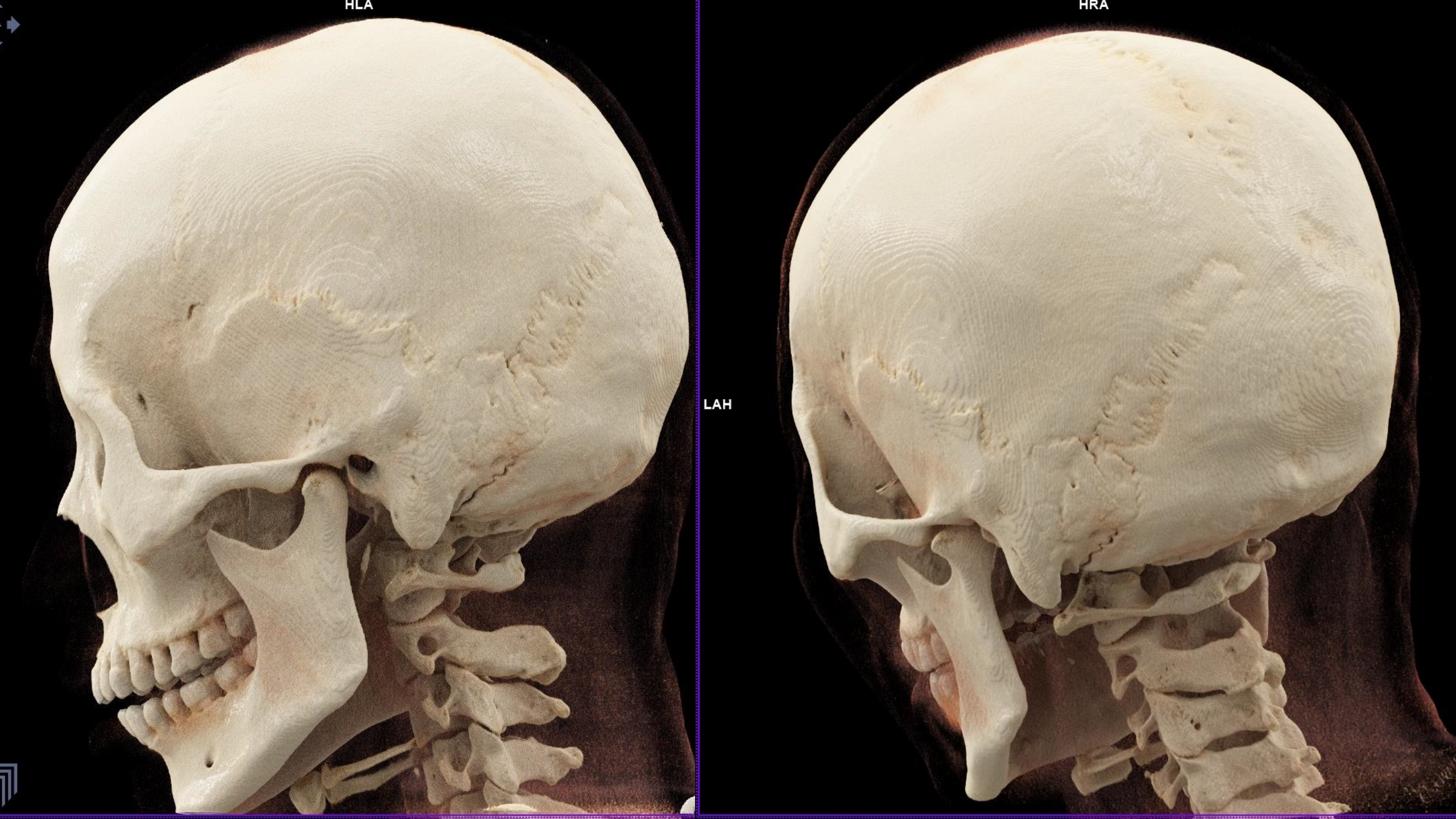


Gray´s Anatomy, 41th ed. 2014

Sutures – sutura ossium

- Sutura serrata – saw-toothed
  - *Ossa suturarum Wormiana*
- Sutura squamosa – squamous
- Sutura plana – flat
- Gomphosis
  - Wedged teeth in alveoli



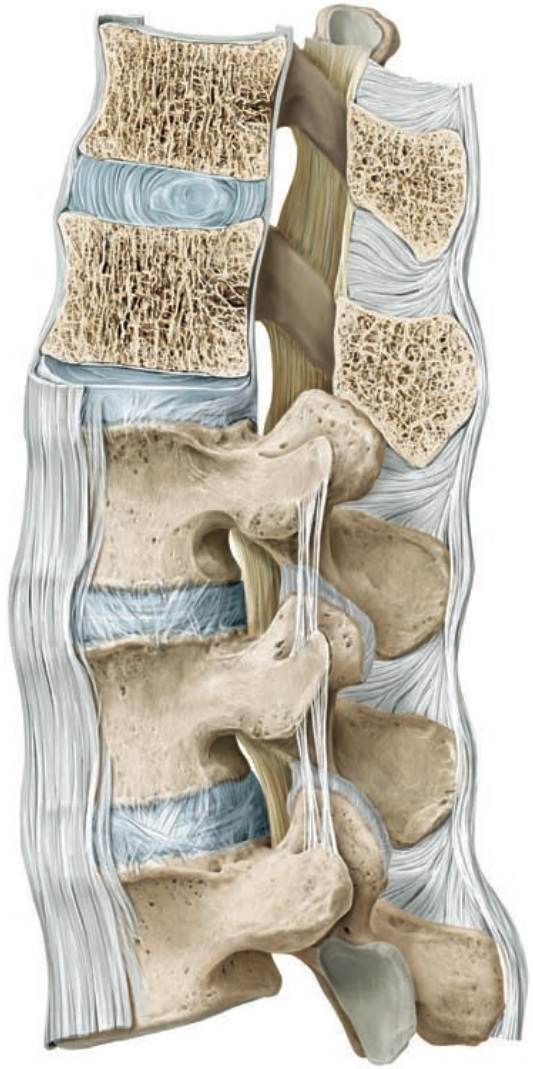

HLA
HRA
LAH

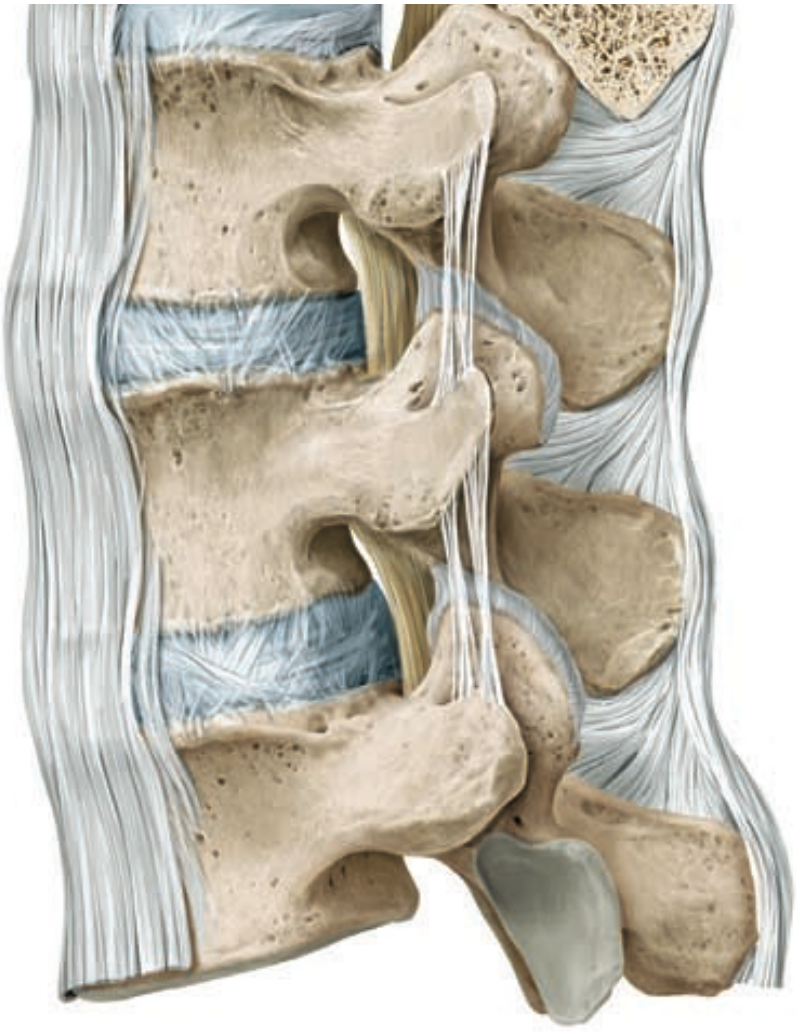
Cranium neonati - fonticuli

Syndesmosis

- Fibrous connection

- Vertebrae
- Ligamenta interspinosa
- Ligamenta longitudinalia
- Ligamenta flava





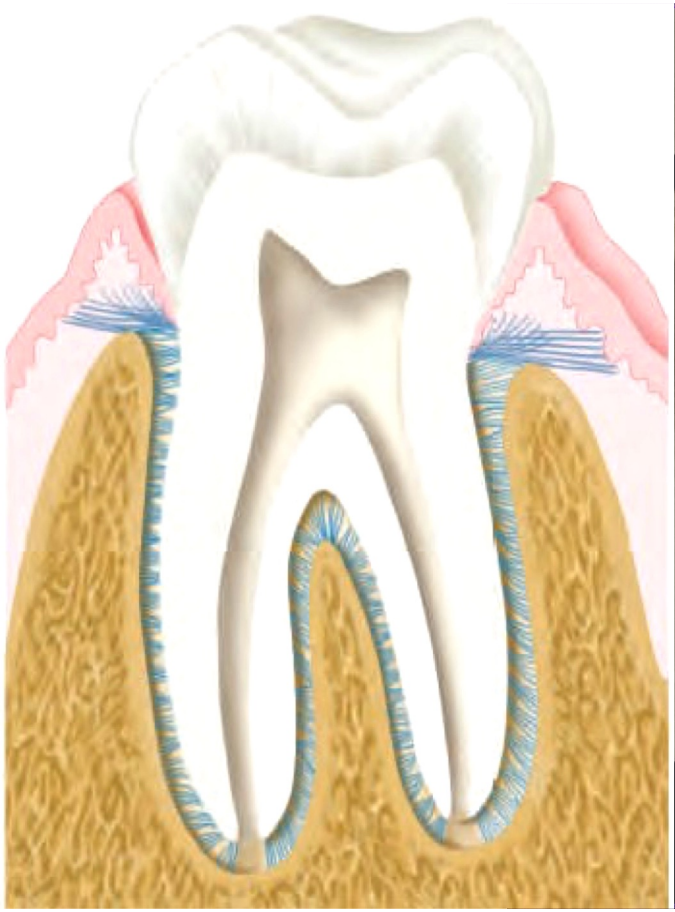
Syndesmosis

- Fibrous connection

- Membrana interossea antebrachii
- Membrana interossea cruris

Gomphosis - inwedging

- Teeths in jaw alveoli

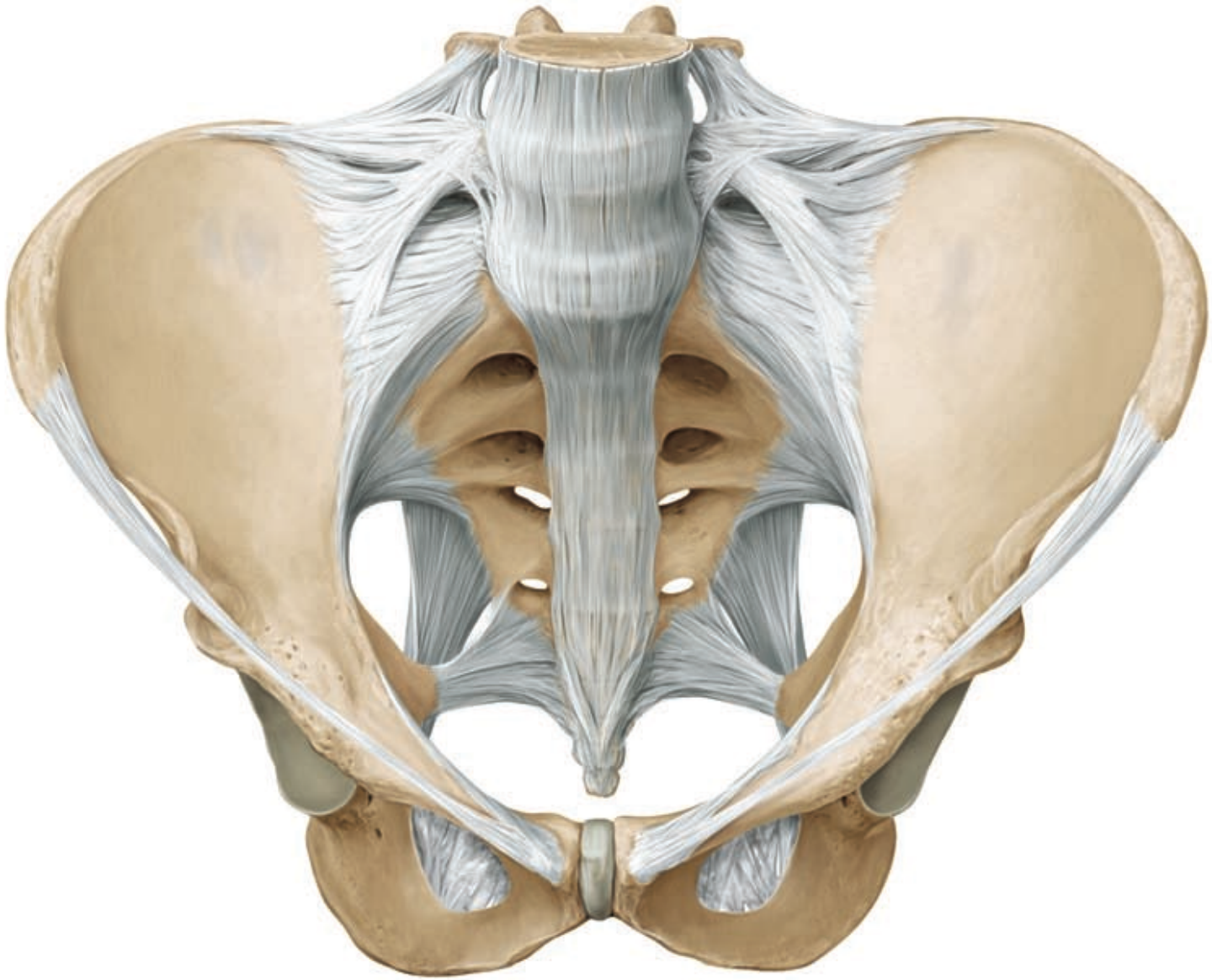


Synchondrosis

- **Connectipon by cartilage**

- **disc**
- *Fibrous cartilage*

- **Symphysis pubis**
- **Columna vertebrarum**

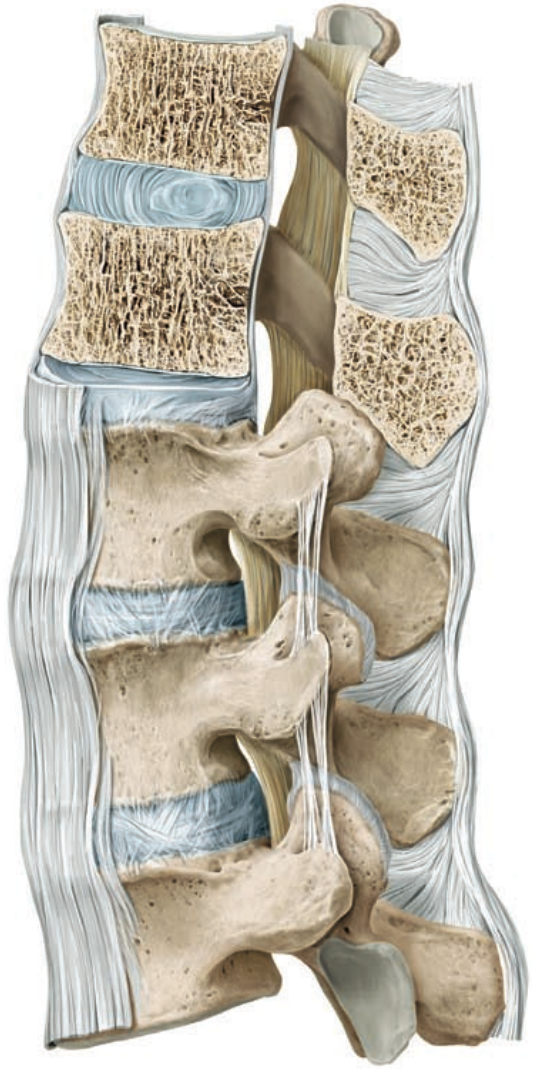


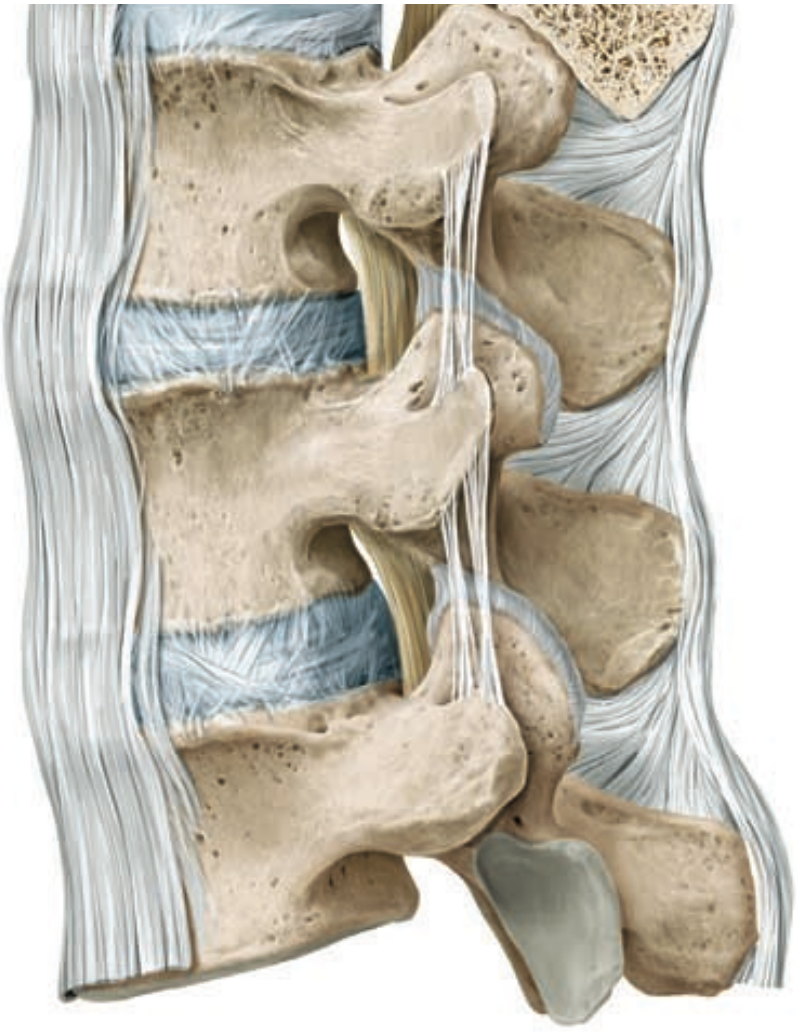
Synchondrosis

- **Connectipon by cartilage**

- **disc**
- *Fibrous cartilage*

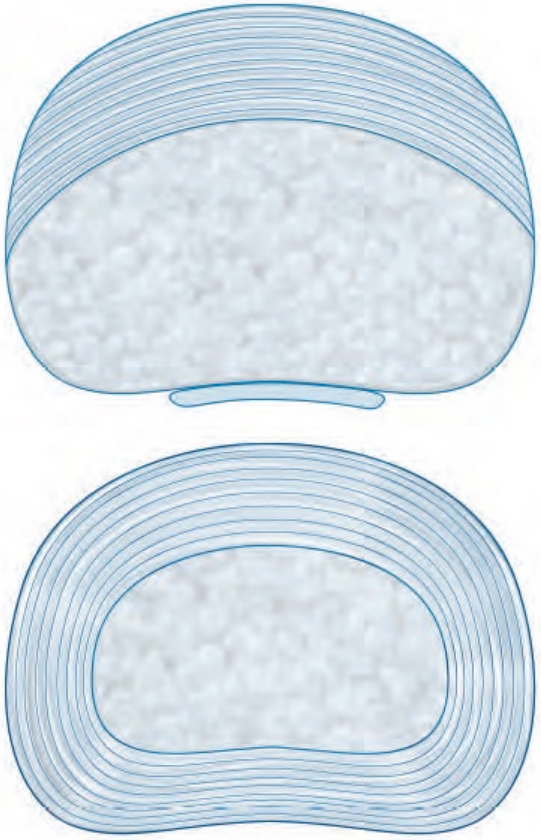
- **Symphysis pubis**
- **Columna vertebrarum**

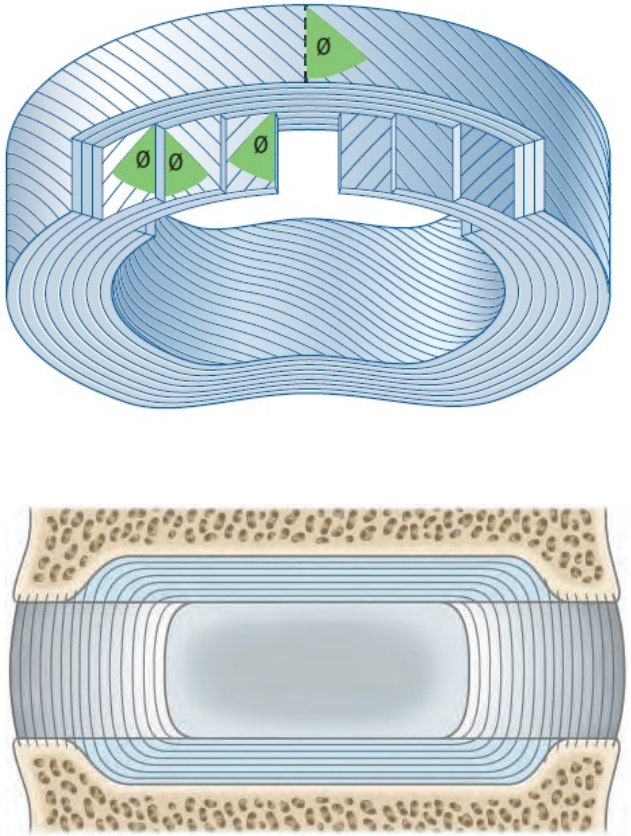


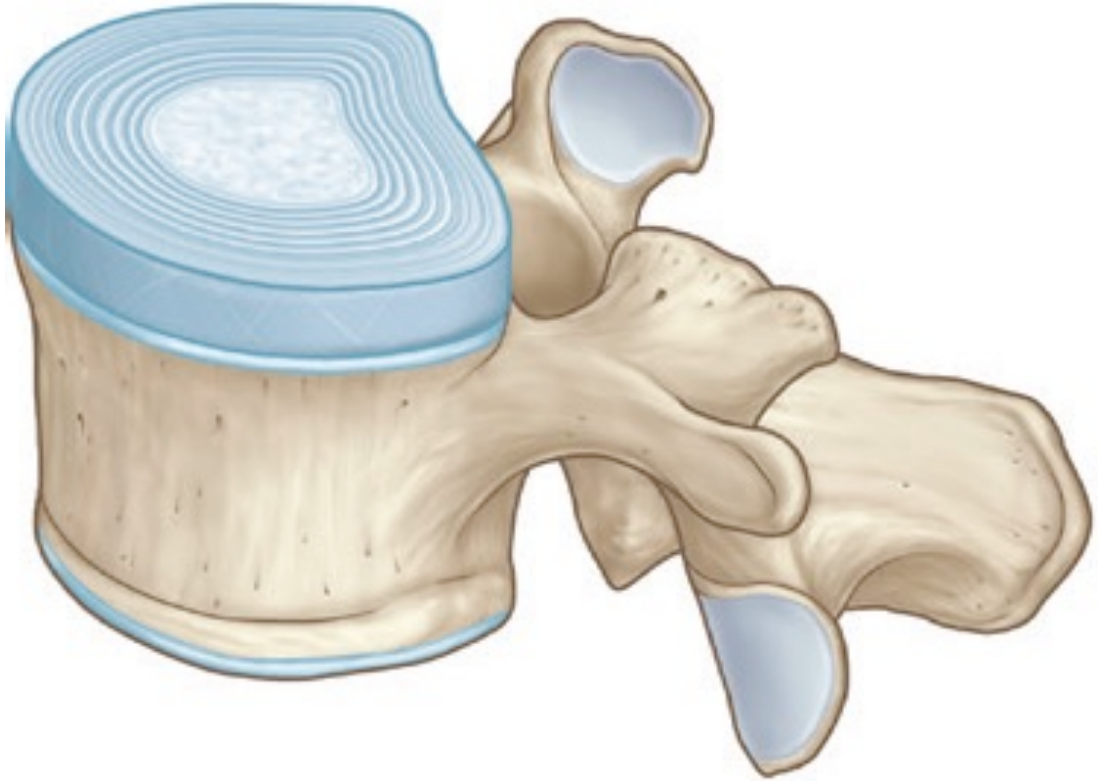


Synchondrosis

- Anulus fibrosus
- Nucleus pulposus



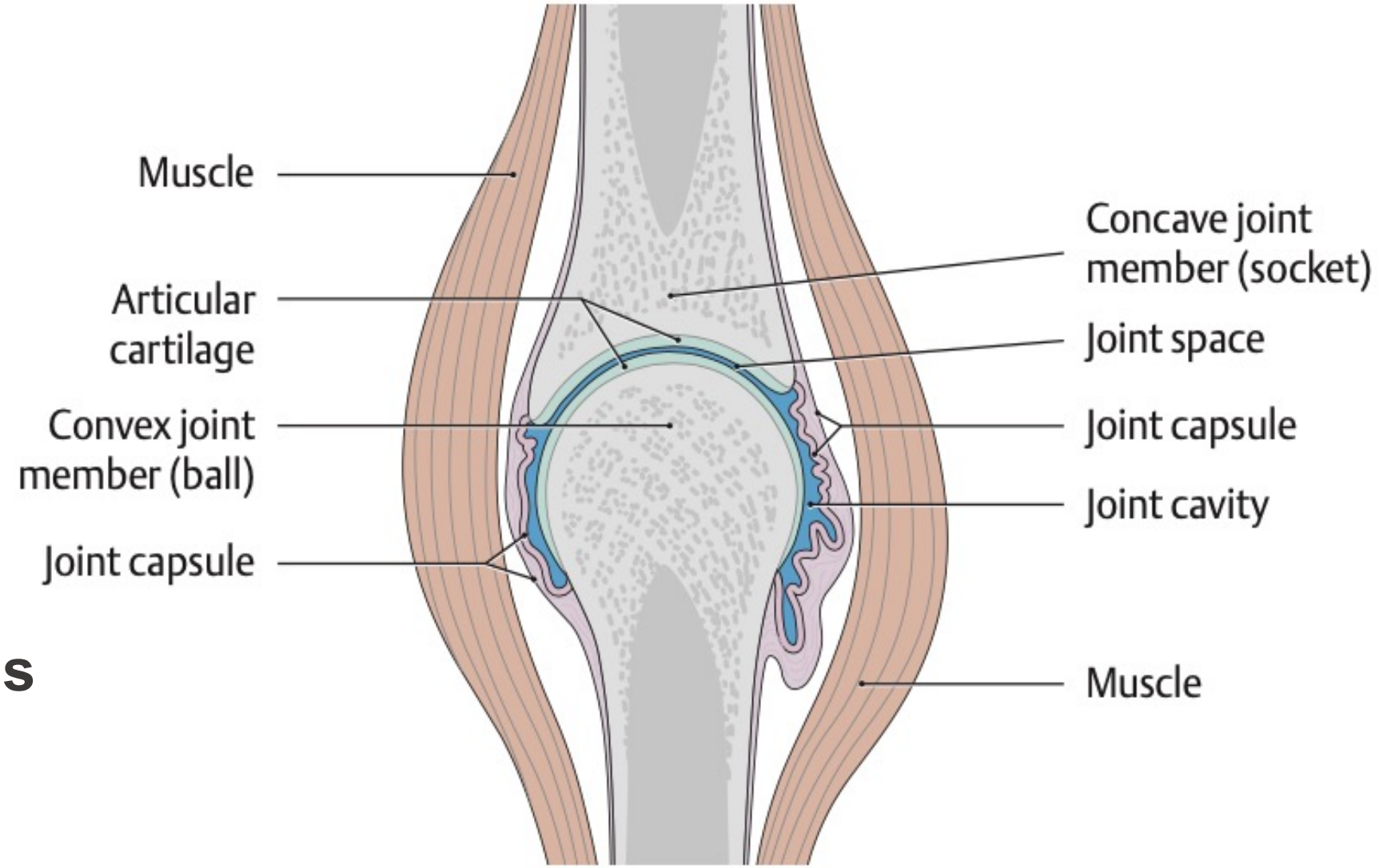




Articulation - joint

- **ball**
- **socket**
- **cartilage**
- **supplements**
  - *Labrum*
  - *Discus*
  - *Meniscus*
  - *Meniscoid*
  - *Intraarticular ligg.*
- **capsula articularis**
  - *stratum fibrosum*
  - *stratum synoviale*

Thieme, Atlas of Anatomy Volume. 1



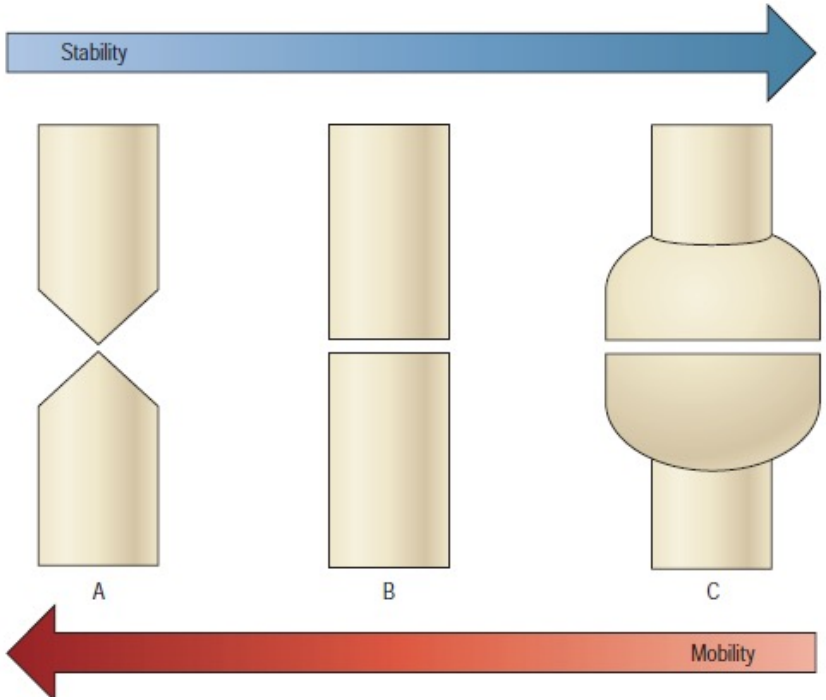
Joint description

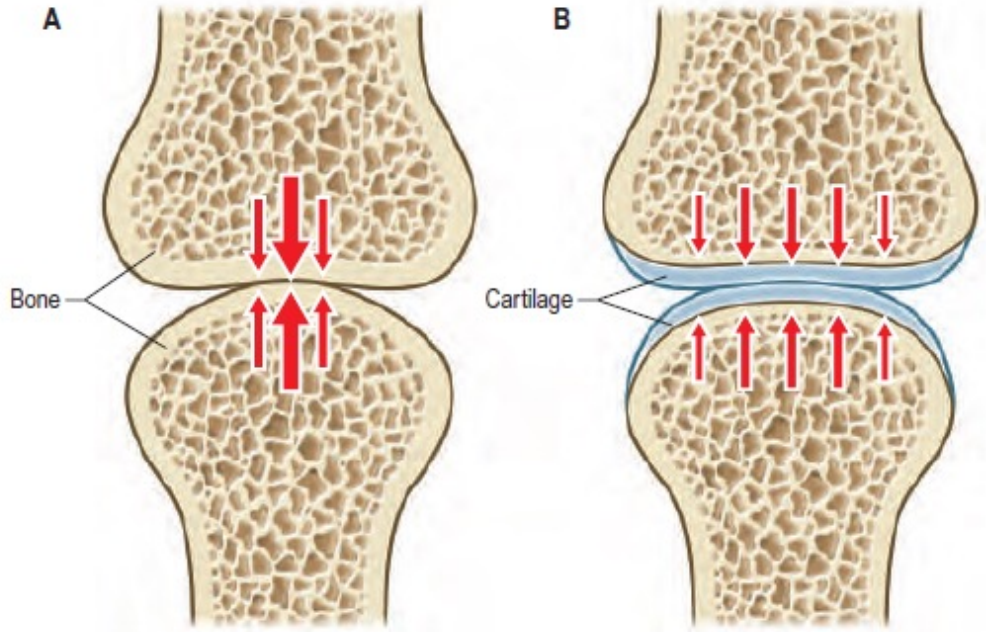
1. Connecting surfaces
2. Capsule
3. Capsular enrichment
4. Basal position
5. Middle position
6. Mechanics

Connecting surfaces

- Different shapes
- Covered by hyaline cartilage
- exception temporomandibular (jaw) joint and clavicular joints - fibrous cartilage
- Supporting structures – labrum glenoidale

Gray´s Anatomy, 41th ed. 2014





Joint cartilage

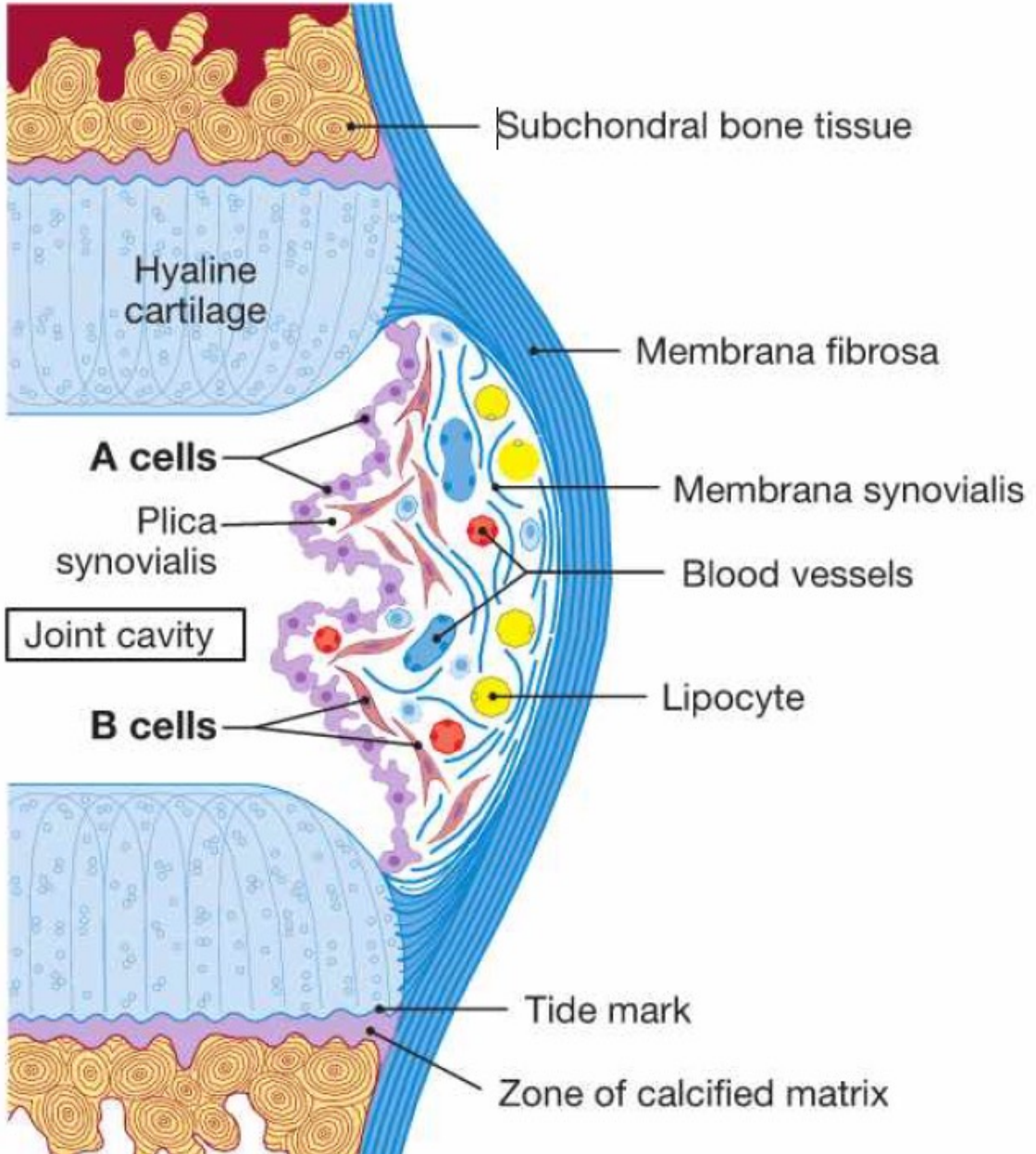
- Forces transmission
- Overloading - pathological inkongruency
- Cartilage´s destruction- osteoarthritis



Inkongruence

Capsula articulationis – joint capsule

- Bound to the margins of connecting planes
- Outer fibrous layer
- Inner synovial layer
- Synovia



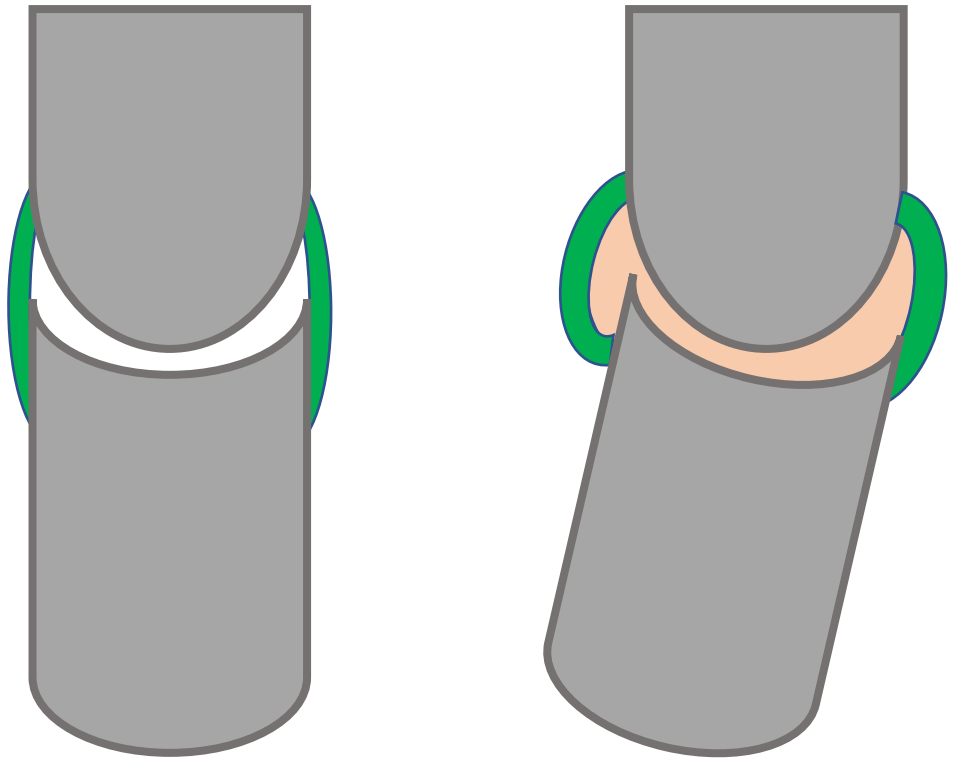
Capsullar accesories - enrichments

- Ligaments
- Tendons
- Muscles
- Cyllindric joints
  - Collateral lig
  - ligg. Colateralia
  - Annular lig.

Gray´s Anatomy, 41th ed. 2014

Base and middle position

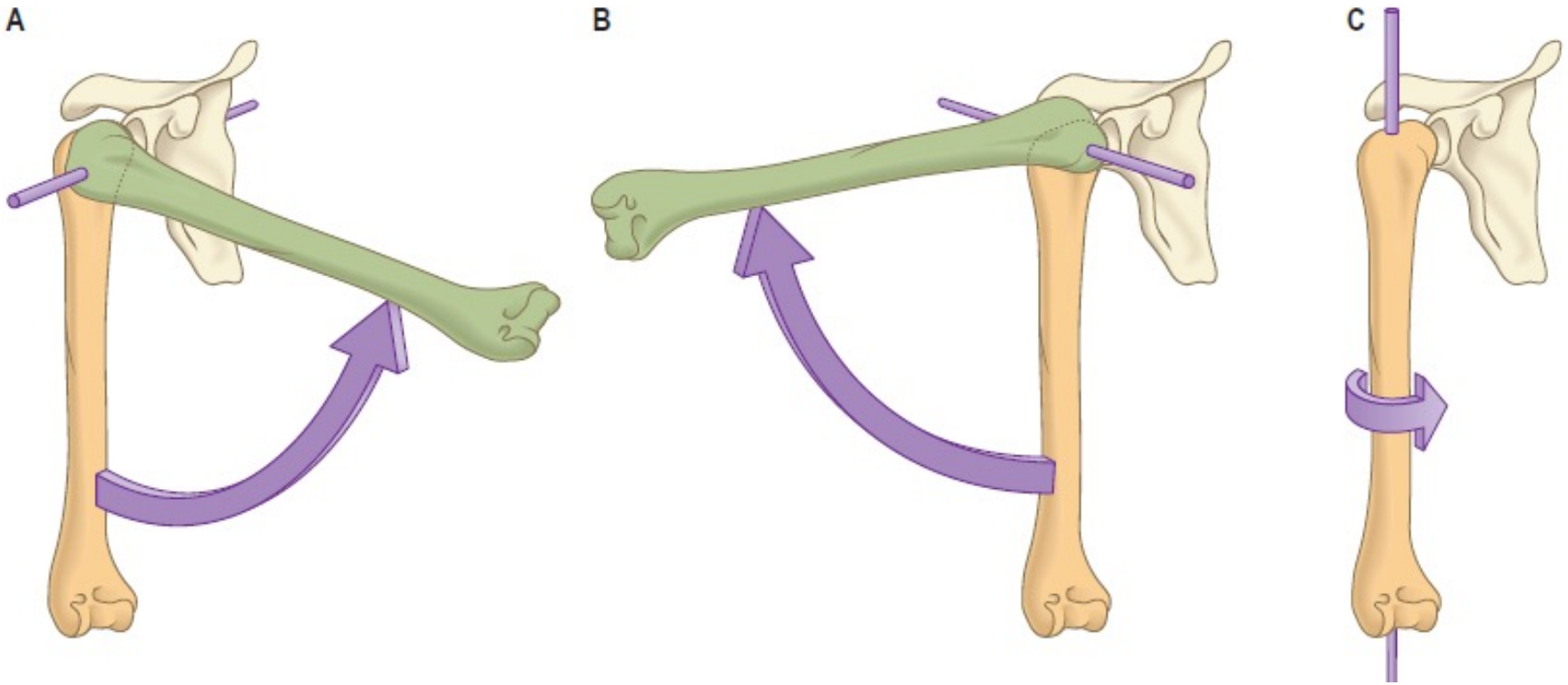
- **Basal position**
  - *Upright position*
  - *Extremities down*
  - *Palms in supination*
- **Middle position**
  - *Minimal capsular tension*
  - *Injuries, infection*



Joint mechanics

- FLEXION
- EXTENSION
  - HORIZONTAL AND FRONTAL AXES
- ABDUCTION
- ADDUCTION
  - HORIZONTAL, SAGITTAL
- INNER ROTATION
- OUTER ROTATION
  - AROUND LIMB AXIS
- CIRKUMDUCTION

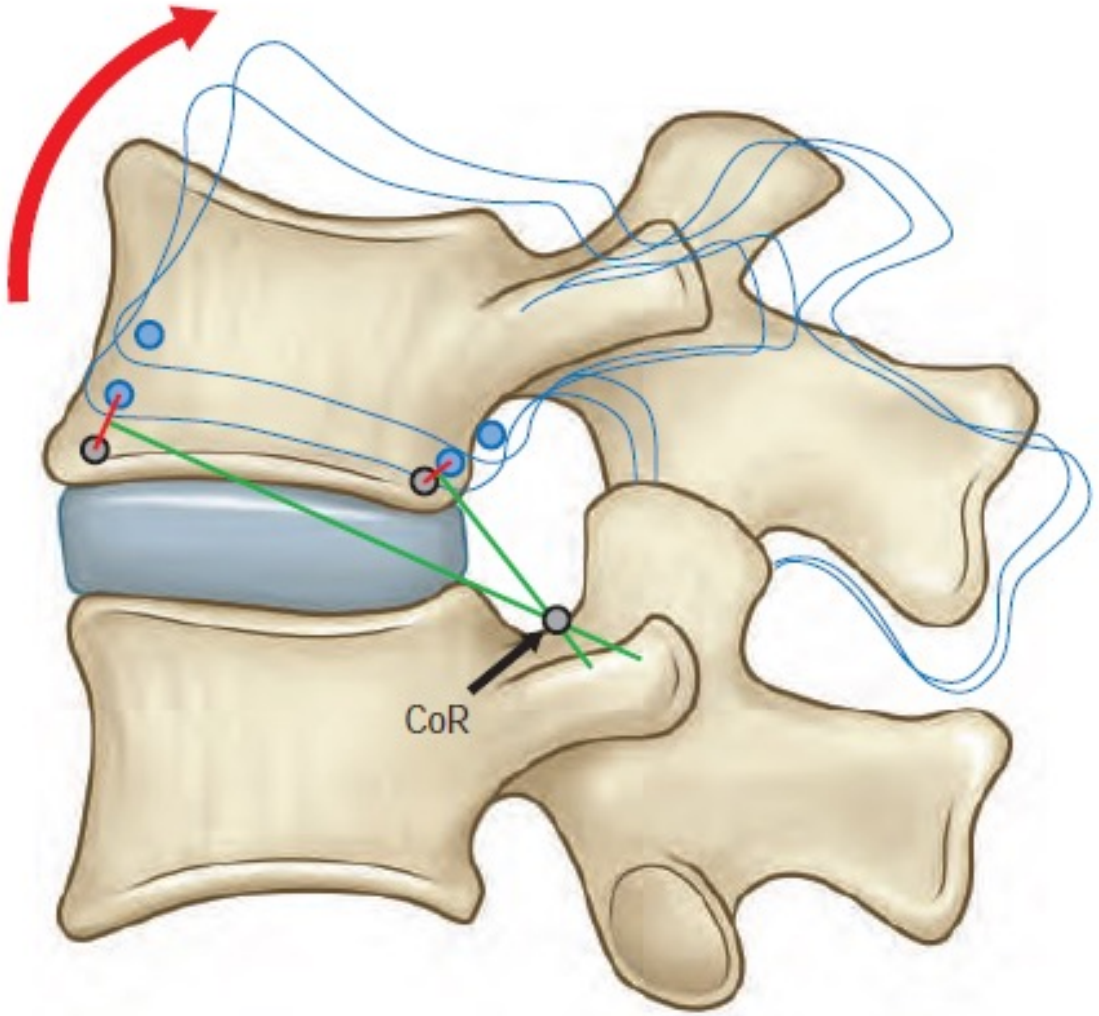
Gray´s Anatomy, 41th ed. 2014



Joint mechanics

- FLEXION
- EXTENSION
  - HORIZONTAL AND FRONTAL AXES
- ABDUCTION
- ADDUCTION
  - HORIZONTAL, SAGITTAL
- INNER ROTATION
- OUTER ROTATION
  - AROUND LIMB AXIS
- CIRKUMDUCTION

Complex motions – addition of movements

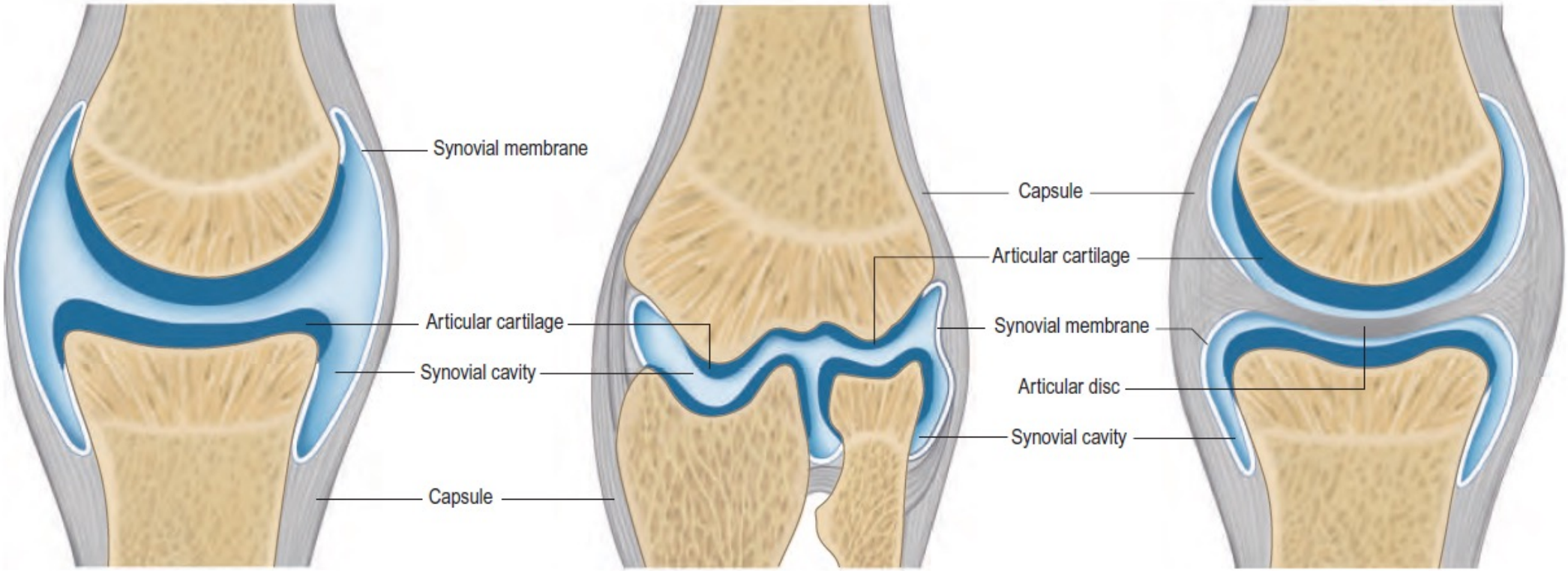


Gray´s Anatomy, 41th ed. 2014

Joints types

- **Number of bones or rotating axes**
- **Simple - articulationes simplices - only two bones**
- **Complex – articulationes compositae - more than two bones or discus or meniscus**

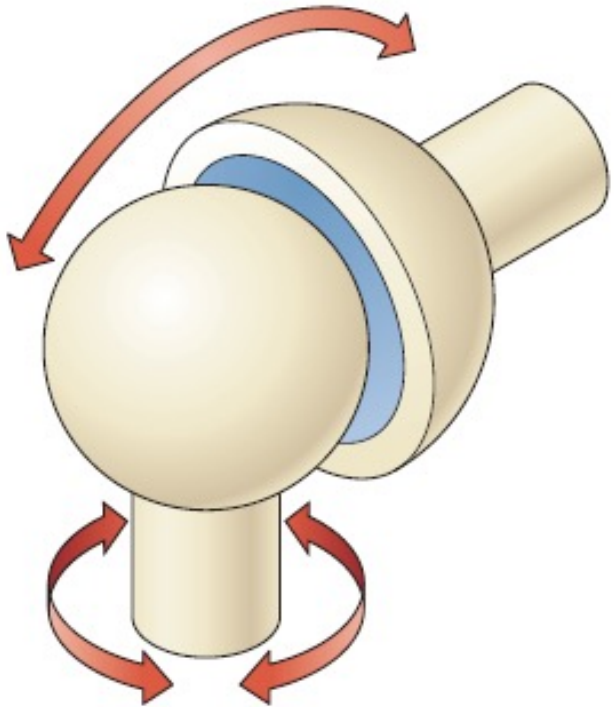
Gray´s Anatomy, 41th ed. 2014

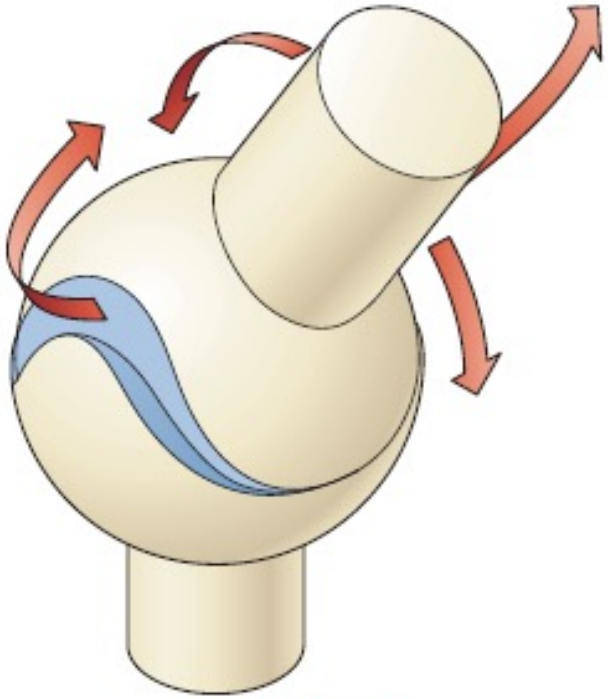


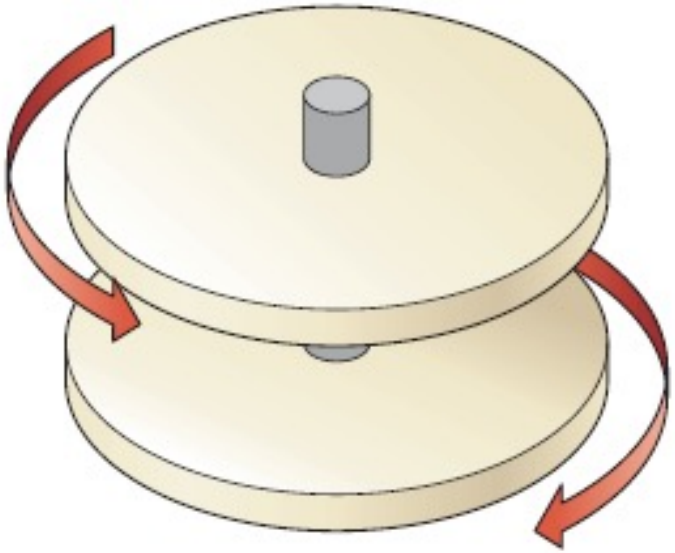
Degrees of freedom

- Three degrees of freedom – art. spheroidea
- Two degrees of freedom – art. sellaris, art. ellipsoidea
- One degree of freedom – art. trochoidea, art. cylindrica

Gray´s Anatomy, 41th ed. 2014

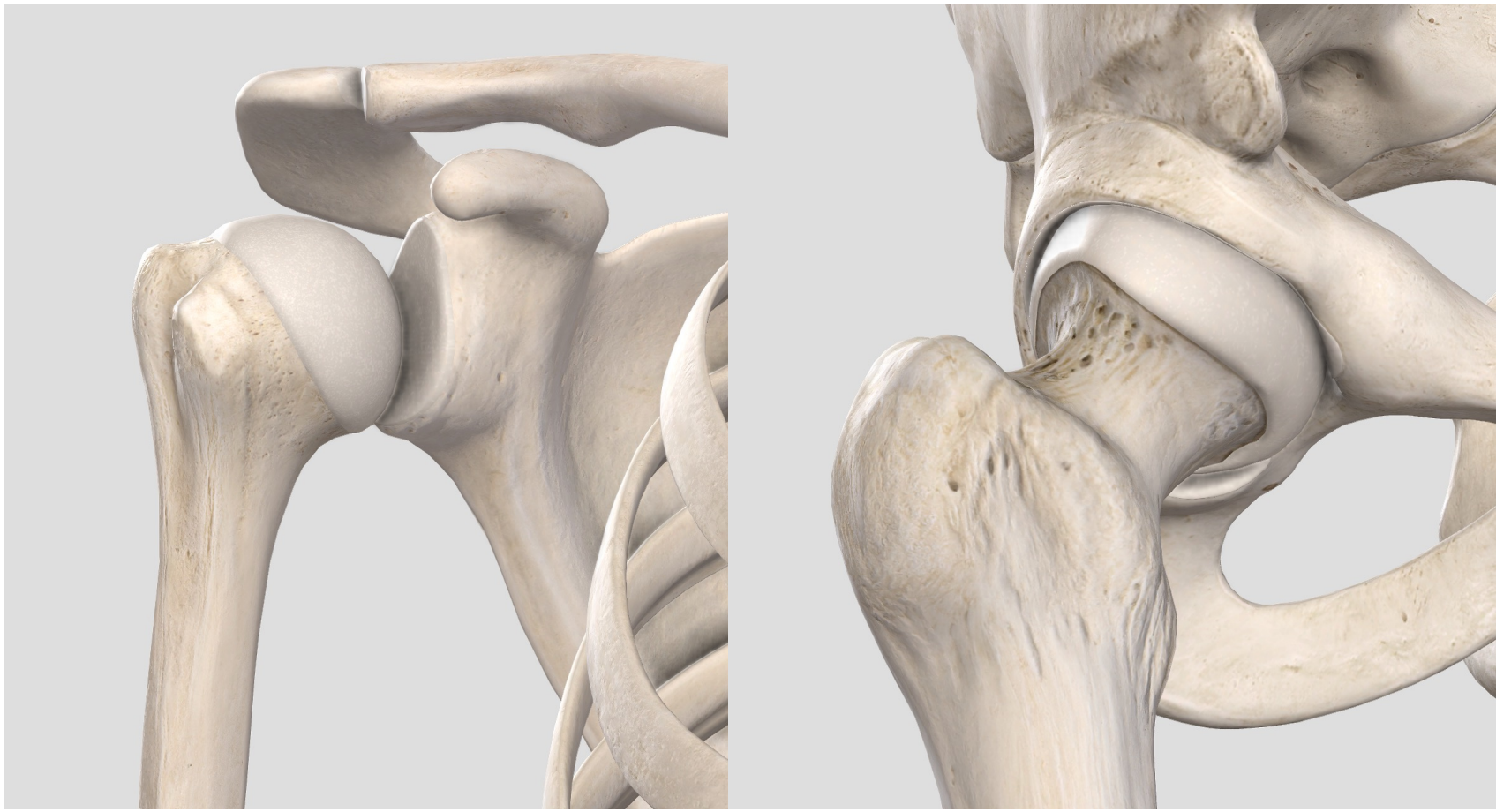






Art. sphaeroidea

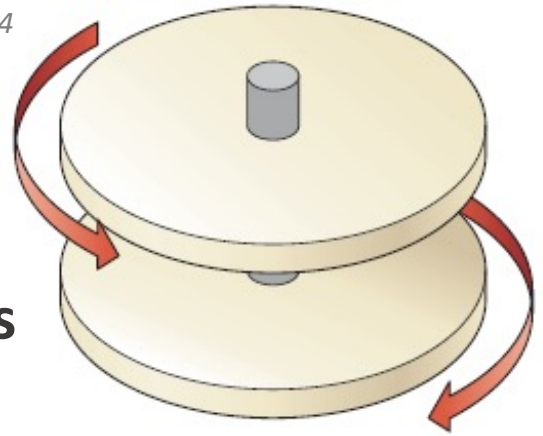
- **Ball and socket**
- **Free – arthrodia**
  - **shoulder**
- **Limited – enarthrosis**
  - **hip**
- **3 degrees of freedom**
- *Transversal*
  - *flexion, extension*
- *Sagittal*
  - *abduction, adduction*
- *Rotation axis*
  - *outer, inner*

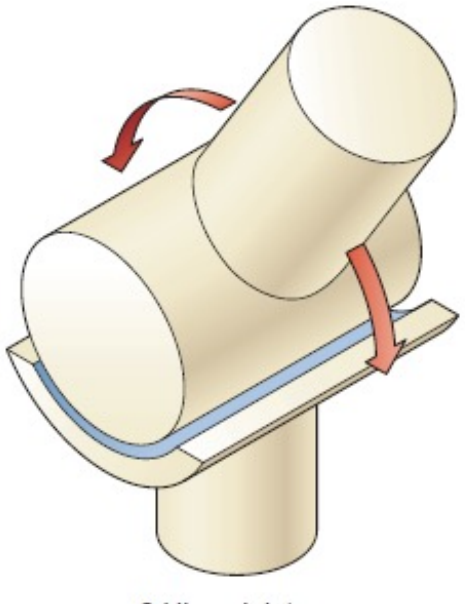


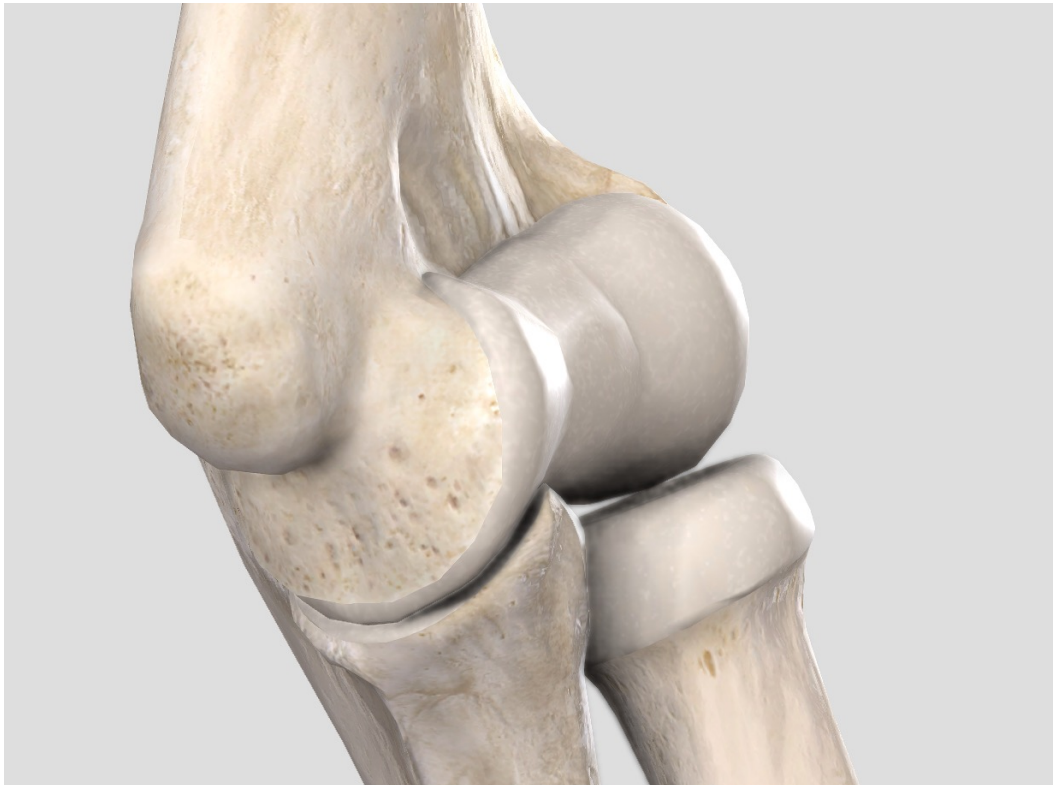
Art. cylindrica

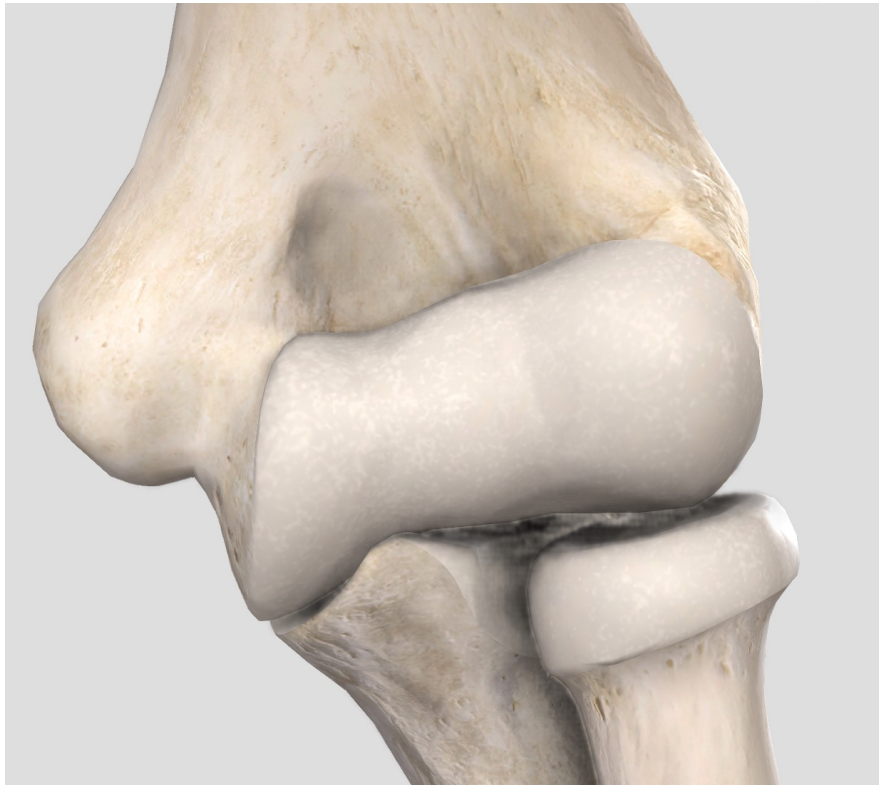
- cylindric
- Gynglymus – axis of rotation perpendicular to bone axis
  - Humeroulnar joint
- Hinge (pivotal) – art. trochoidea – axis of rotation parallel to bone axis
  - Prox. radioulnar joint

Gray´s Anatomy, 41th ed. 2014







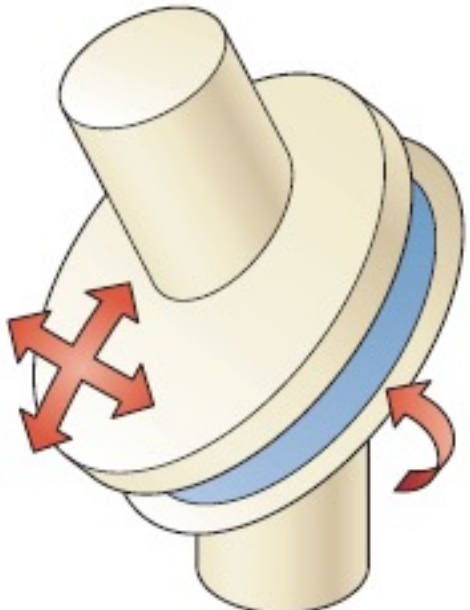


Art. trochlearis

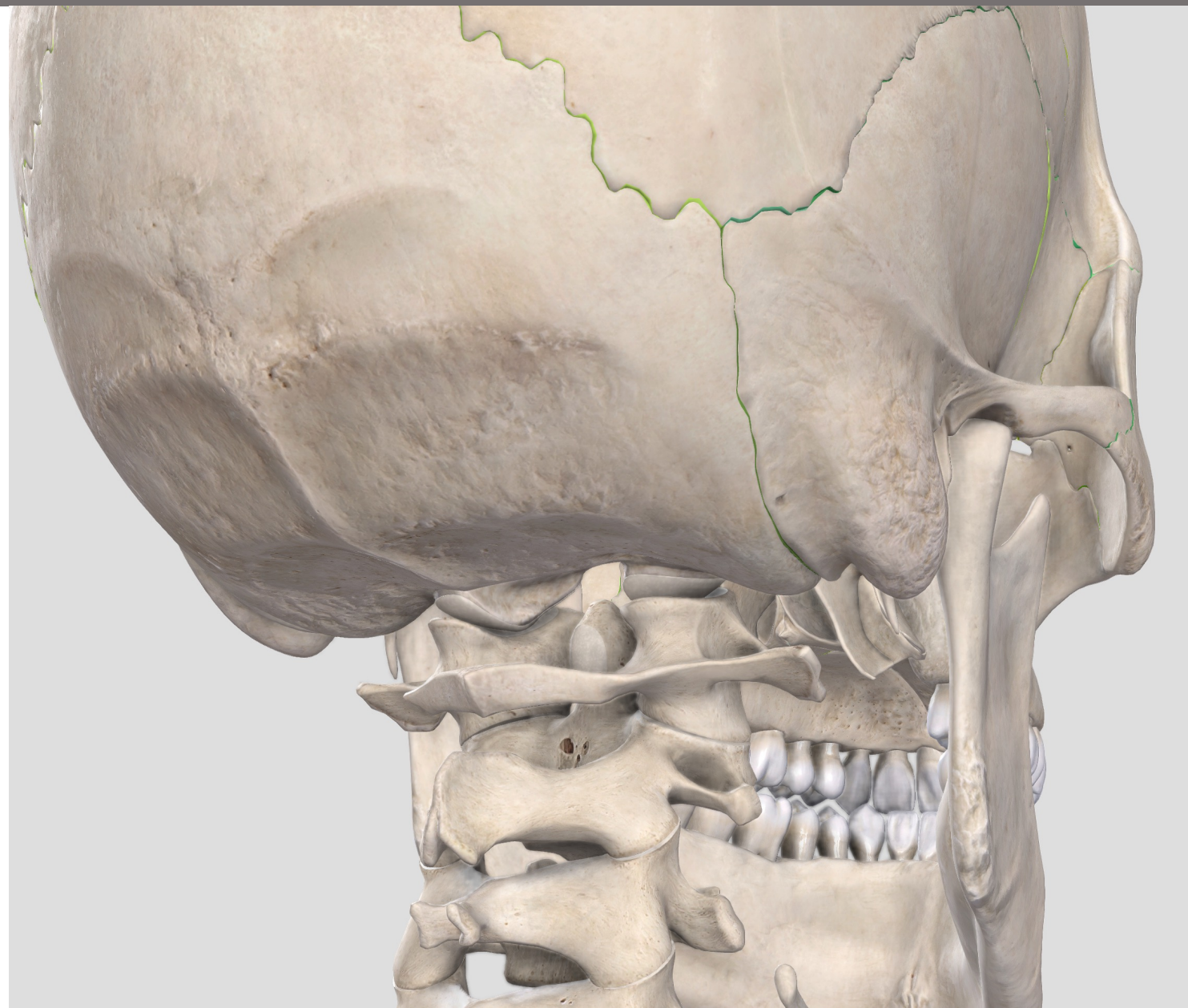
- **Tackle**
  - **Art. humeroulnaris**
  - **Art. interphalangealis**
  - **Art. genus**
- **Axis of rotation perpendicular to bone axis**
  - *Flexion, extension*
  - *Leading groove and ridge*

Art. elipsoidea

- **Ellipsoid - egg shaped**
- ***Atlantooccipital***
- *Transverse axis*
- *Flexion, extension*
- *Sagittal lateroflexion*



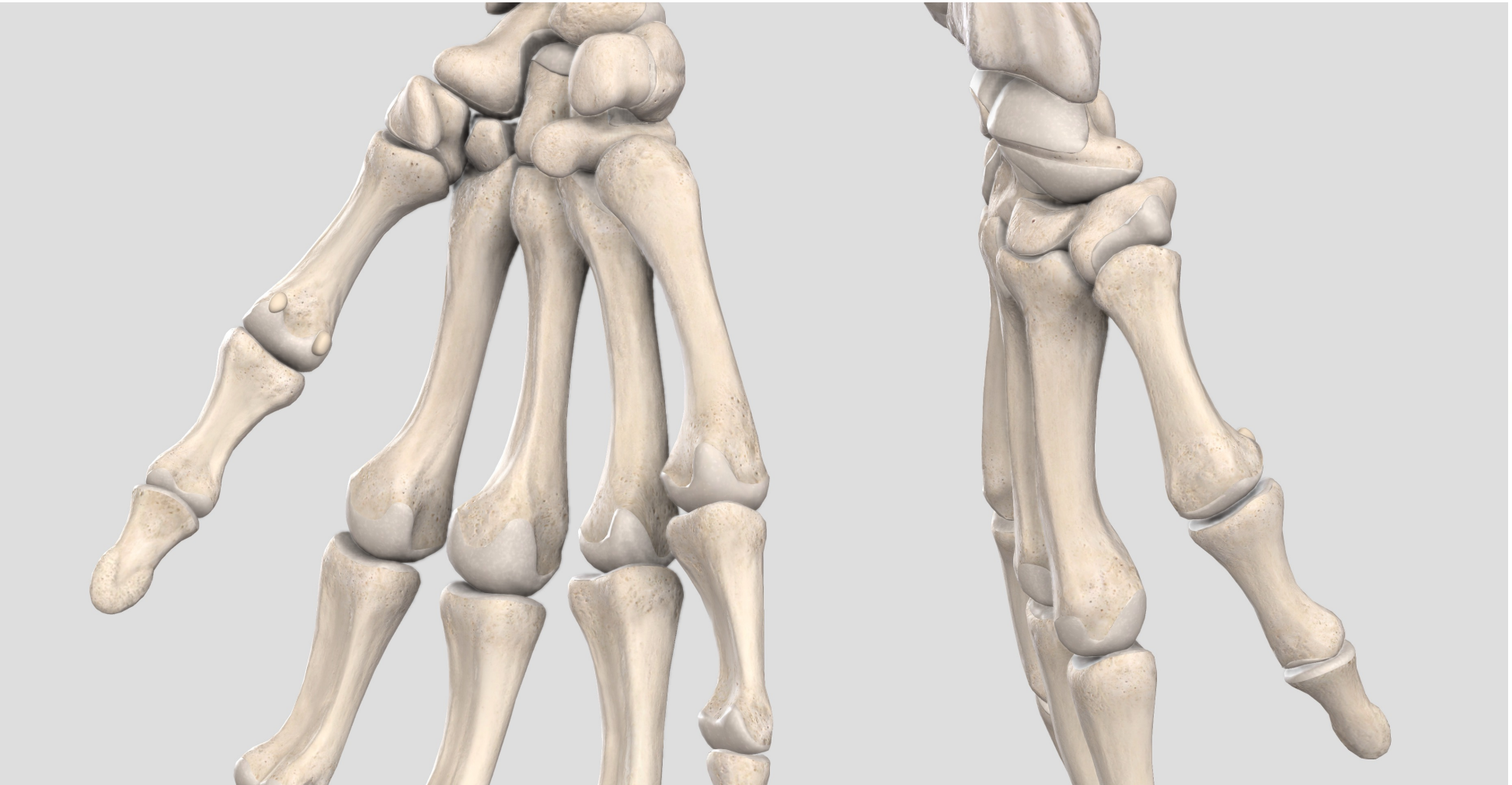
Gray´s Anatomy, 41th ed. 2014

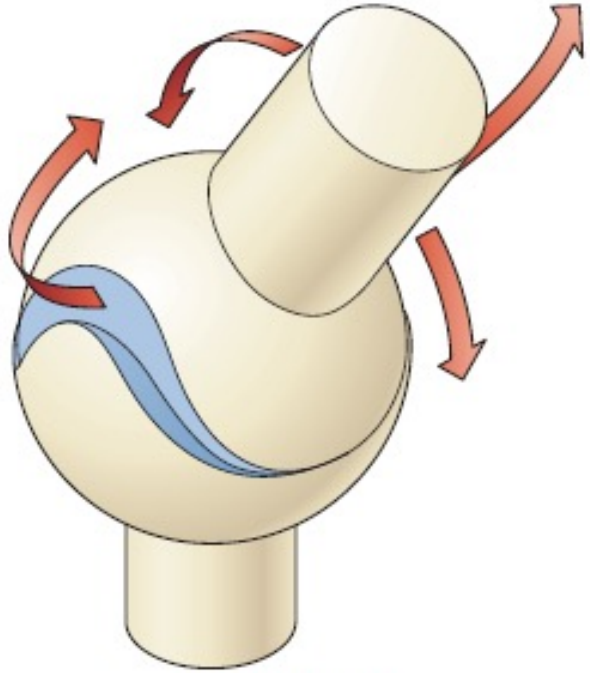


Art. sellaris

- **Saddle joint**
- **Os trapezium + I. metacarpus**

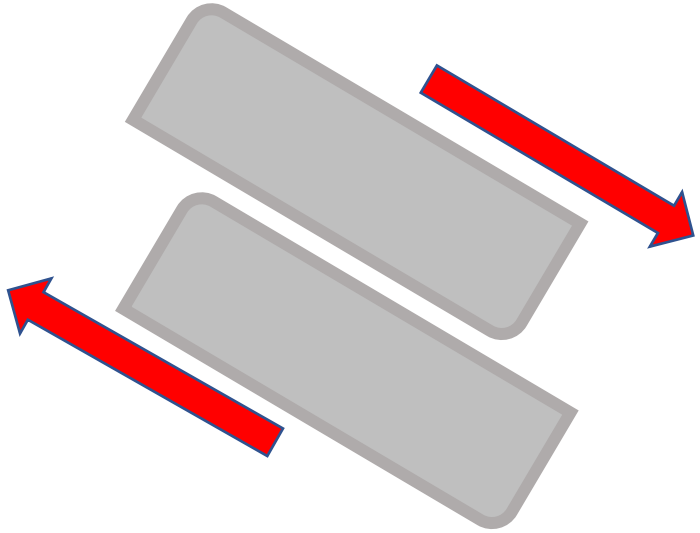
Gray´s Anatomy, 41th ed. 2014





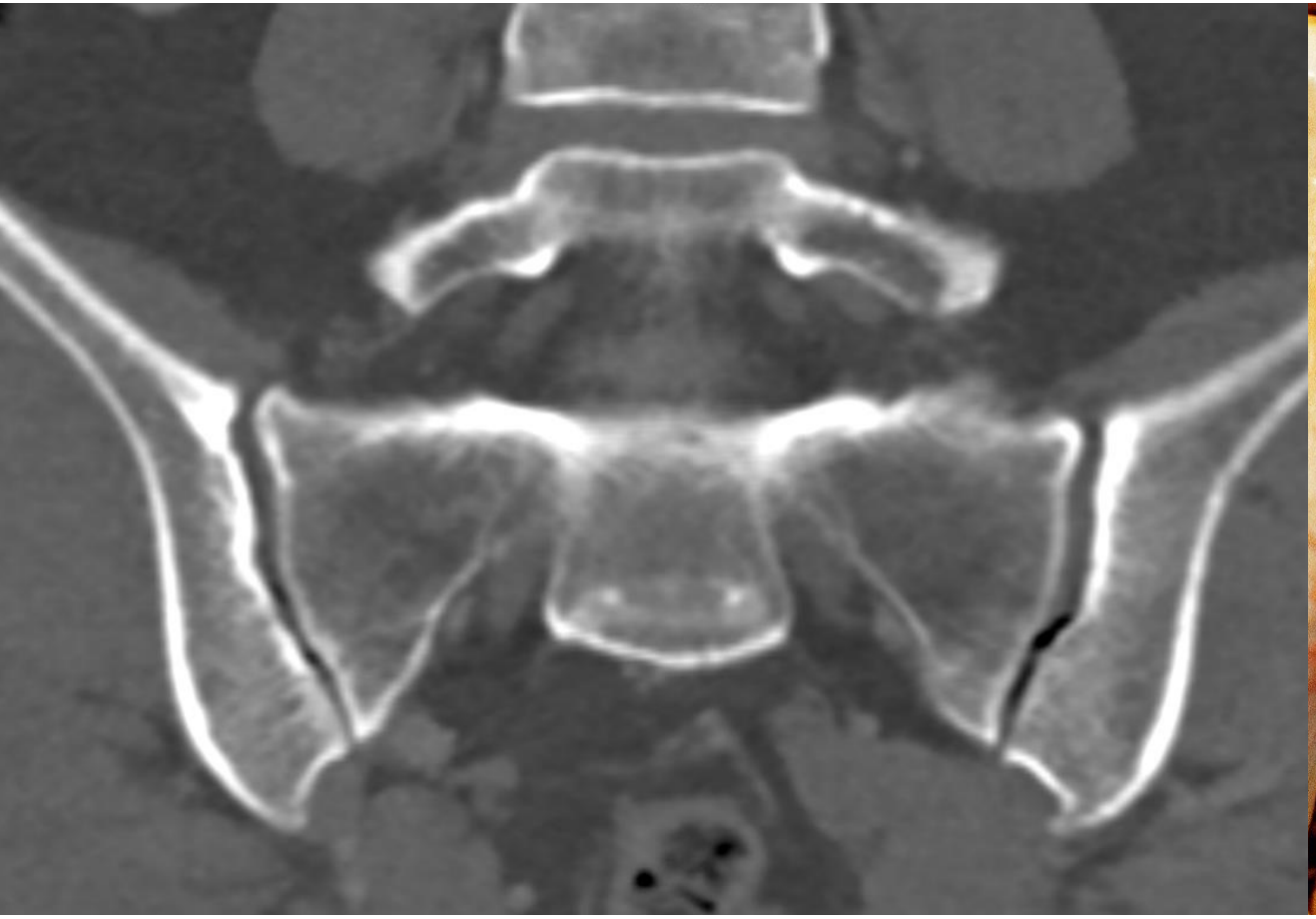
Art. plana

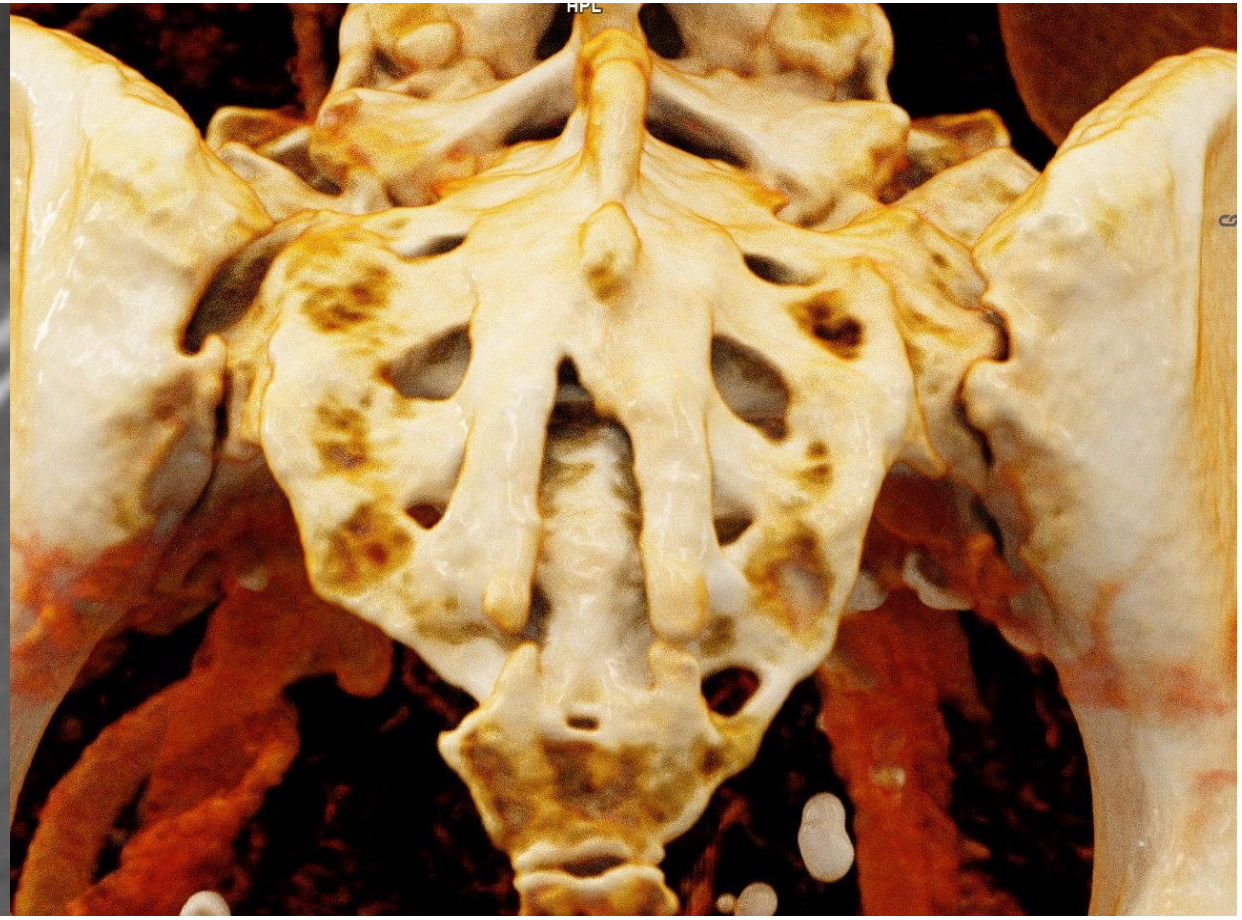
- Flat joint - sliding surfaces
- Os naviculare + ossa cuneiformia
- Art. interverstebrales (zygophyseales)



Amphiarthrosis

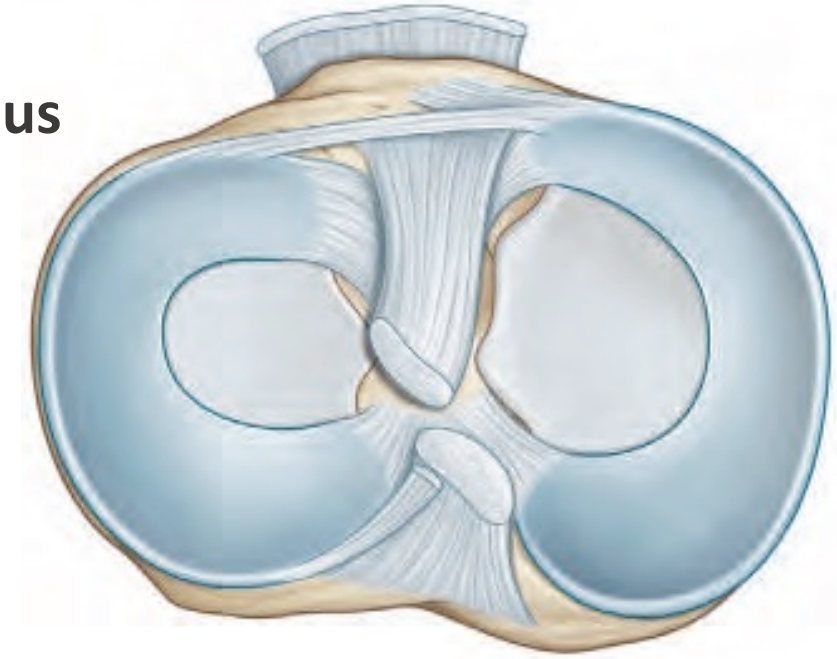
- **Stiff joint**
- *Art. sacroiliaca - minimal movements - irregular joint surfaces*





Art. composita

- **Complex joint**
- More bones
- Art. cubiti – humerus+ulna+radius
- **Interposition of**
  - **DISCUS**
  - art. sternoclaviculare, art. temporomandibularis
  - Coin shape
  - **MENISCUS** – art. genus
  - Halfmoon shape



Gray´s Anatomy, 41th ed. 2014

General anatomy 2.