Sistem skeletale and Arthrology

NUR ARFIAN
DEP ANATOMI FK UGM

SISTEM LOKOMOSI

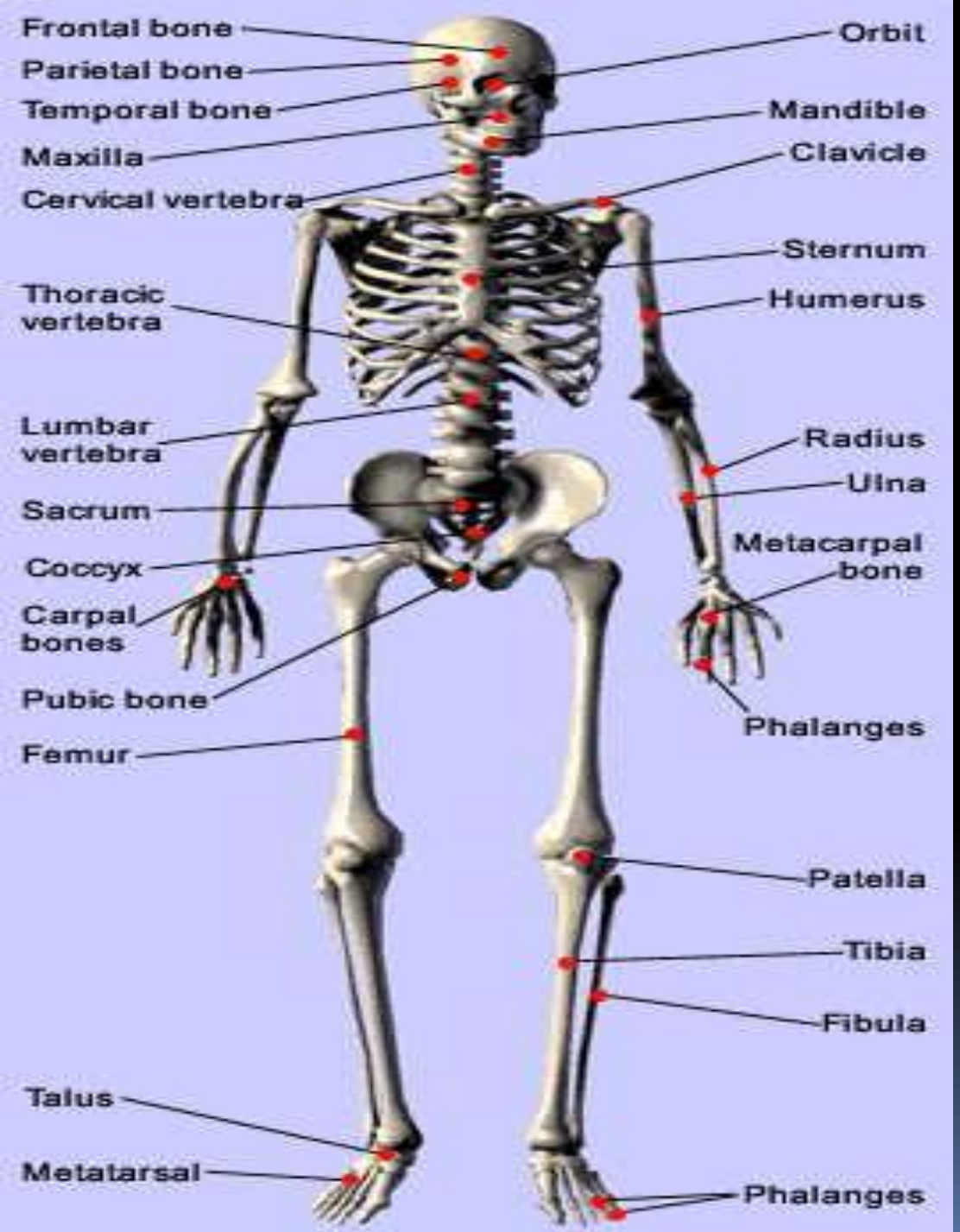
- Gerak manusia:- performance (kinerja), adaftif (efisien); Gerakan & berpindah tempat ; manusia bipedal (extremitas superior), prehensile (jari-jari tangan)
- Kinesiologi = ilmu tentang gerak (Anatomi, Fisiologi & Biomekanika)
- Biomekanika: cabang kinesiologi menerapkan hukum mekanika pada sistem biologis
- Sistem lokomosi : sistem otot, sistem tulang & persendian dan syaraf

SYSTEMA SKELETALE

- Bone and Cartilage
- Skeleton (Latin) = kerangka
- Osteon = tulang (Yunani), os = name of the bone
- Osteology = ilmu tentang tulang

Function:

- Form and support body
- Passive movement without muscle
- Muscle attachment
- Visceral organs protection
- Hematopoesis (blood cells production) in medlla osseus
- Calcium deposition

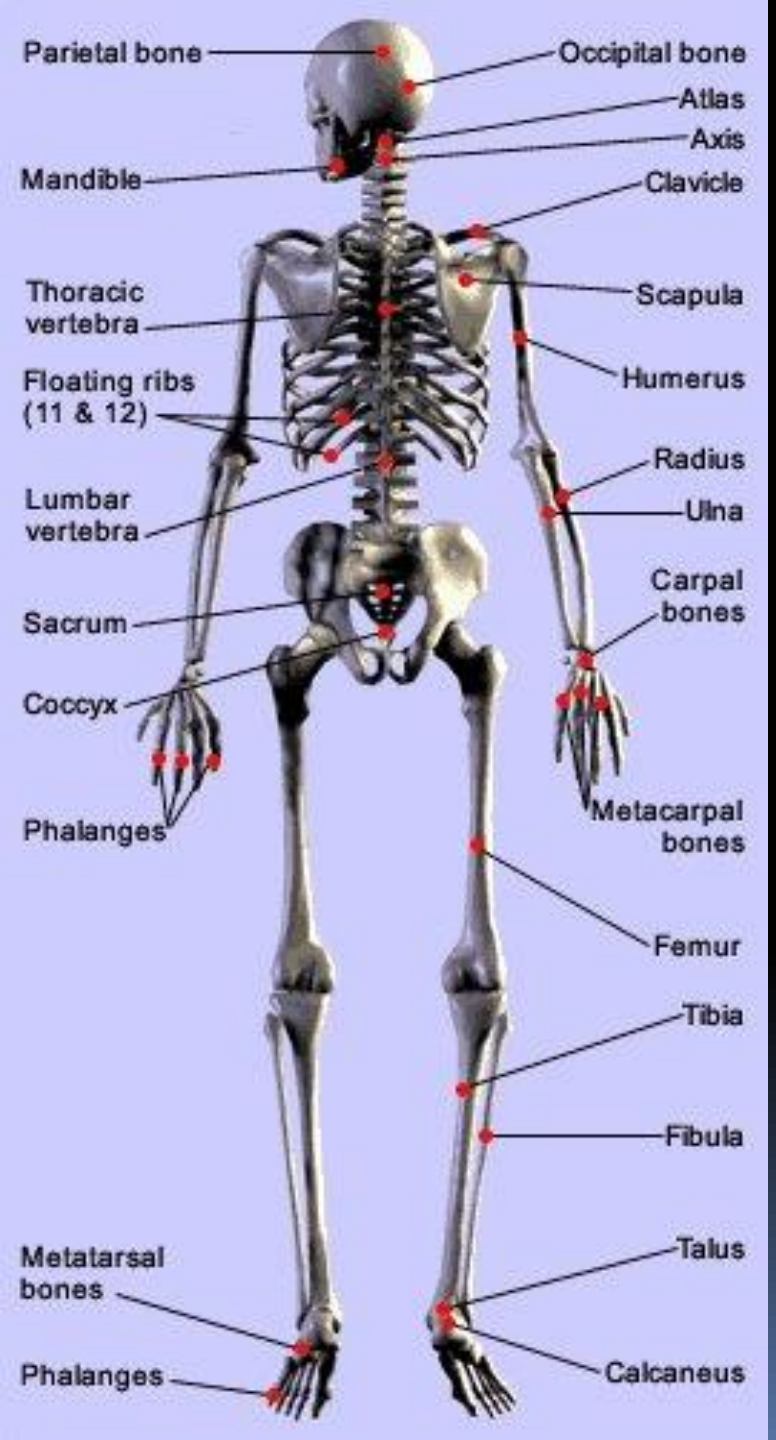


- SKELETON HUMANUM

  Axial skeleton/ Skeleton axiale (80) and

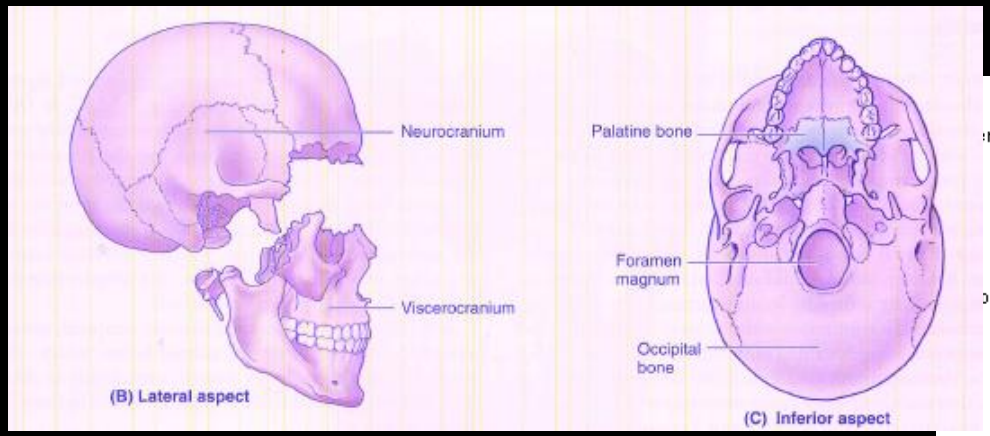
  Appendiculare skeleton / Skeleton appendiculare (126)

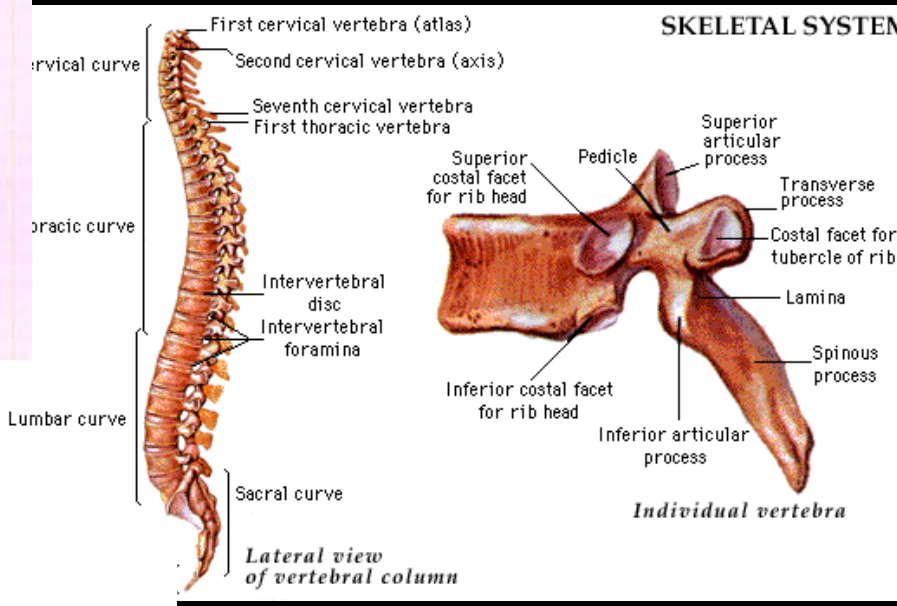
  (DEWASA=206 TULANG)

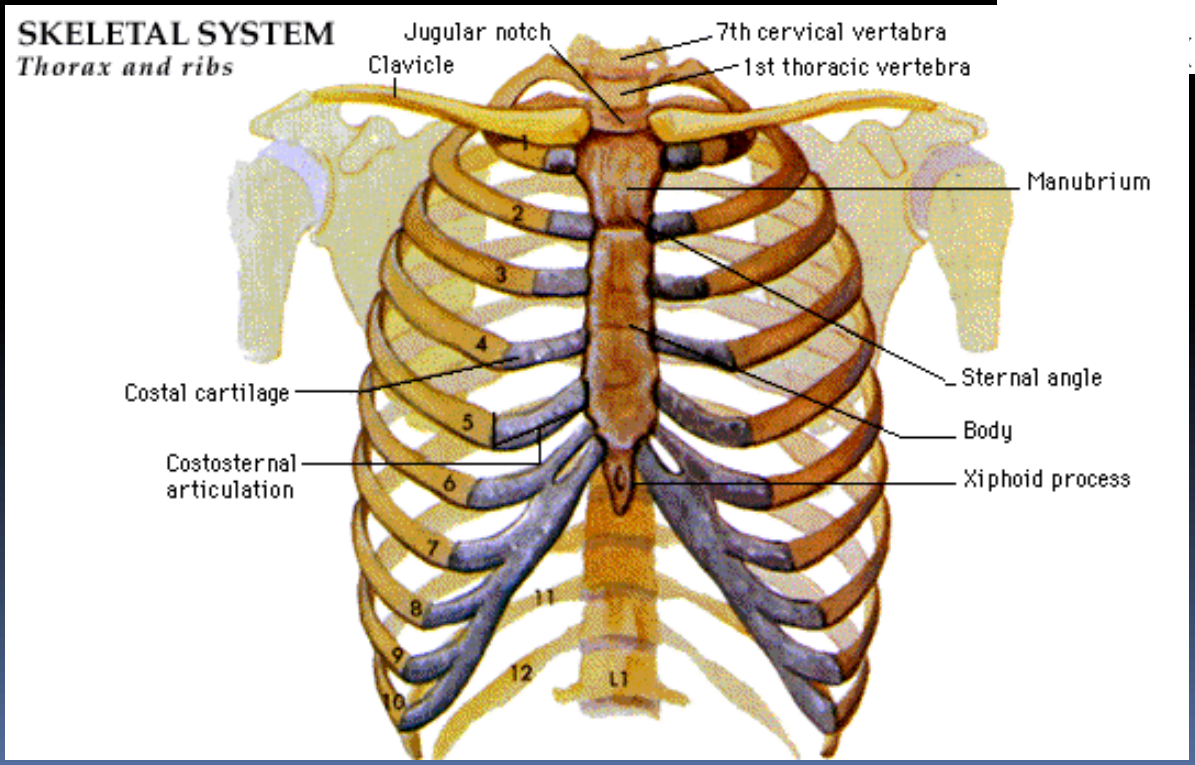


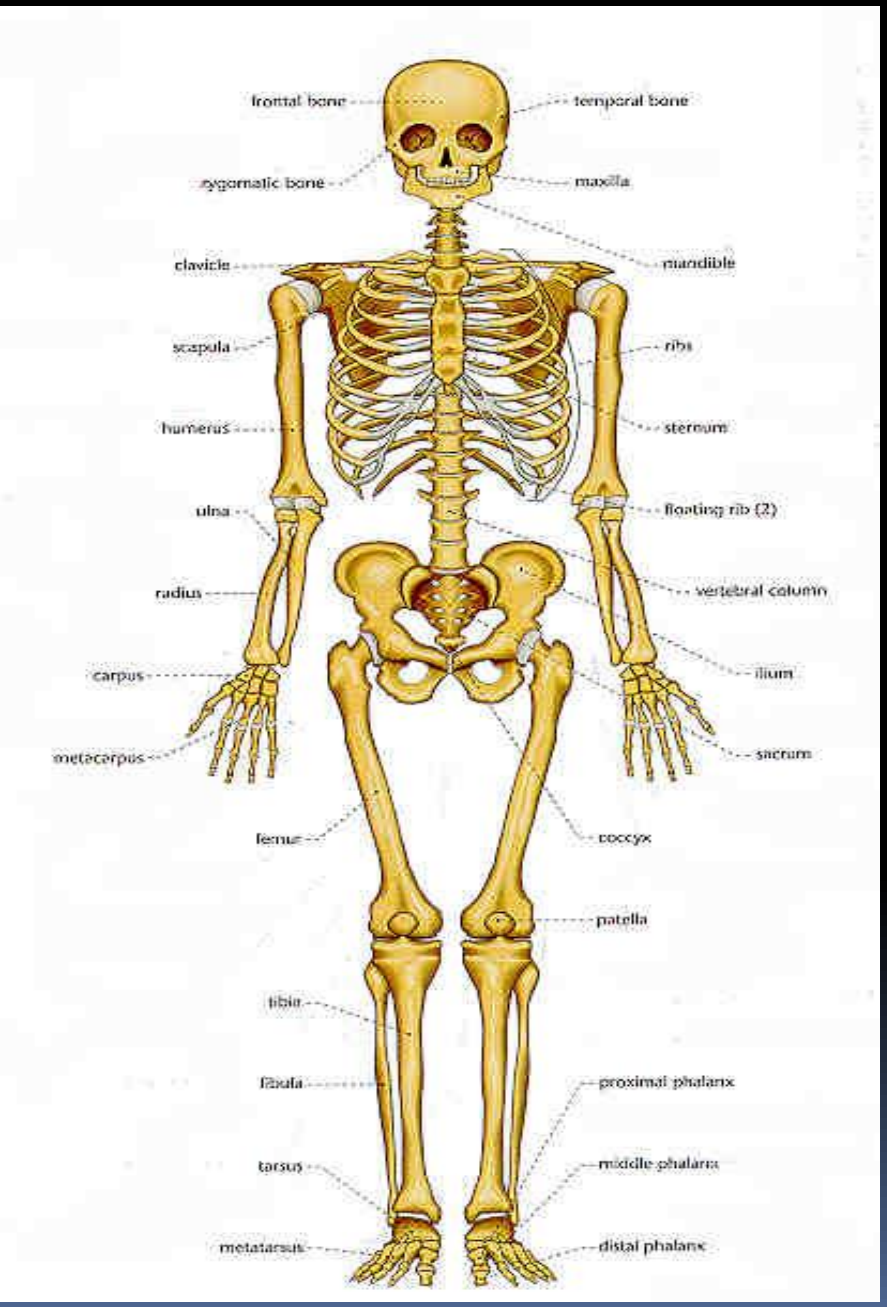
SKELETON AXIALE (80 TULANG)

- Cranium = 29 tulang
- Ossa cranii = 8 pasangan, 7 tunggal= 23 tulang
- Ossicula auditiva= 3 pasang = 6 tulang
- Columna vertebralis = 26 tulang
- Costa et cartilago costa = 24 tulang
- Sternum = 1 tulang


Neurocranium
Viscerocranium
(B) Lateral aspect
Palatine bone
Foramen magnum
Occipital bone
(C) Inferior aspect


SKELETAL SYSTEM
First cervical vertebra (atlas)
Second cervical vertebra (axis)
Seventh cervical vertebra
First thoracic vertebra
Intervertebral disc
Intervertebral foramina
Lumbar curve
Sacral curve
Lateral view of vertebral column
Superior articular process
Pedicle
Superior costal facet for rib head
Transverse process
Costal facet for tubercle of rib
Lamina
Spinous process
Inferior costal facet for rib head
Inferior articular process
Individual vertebra

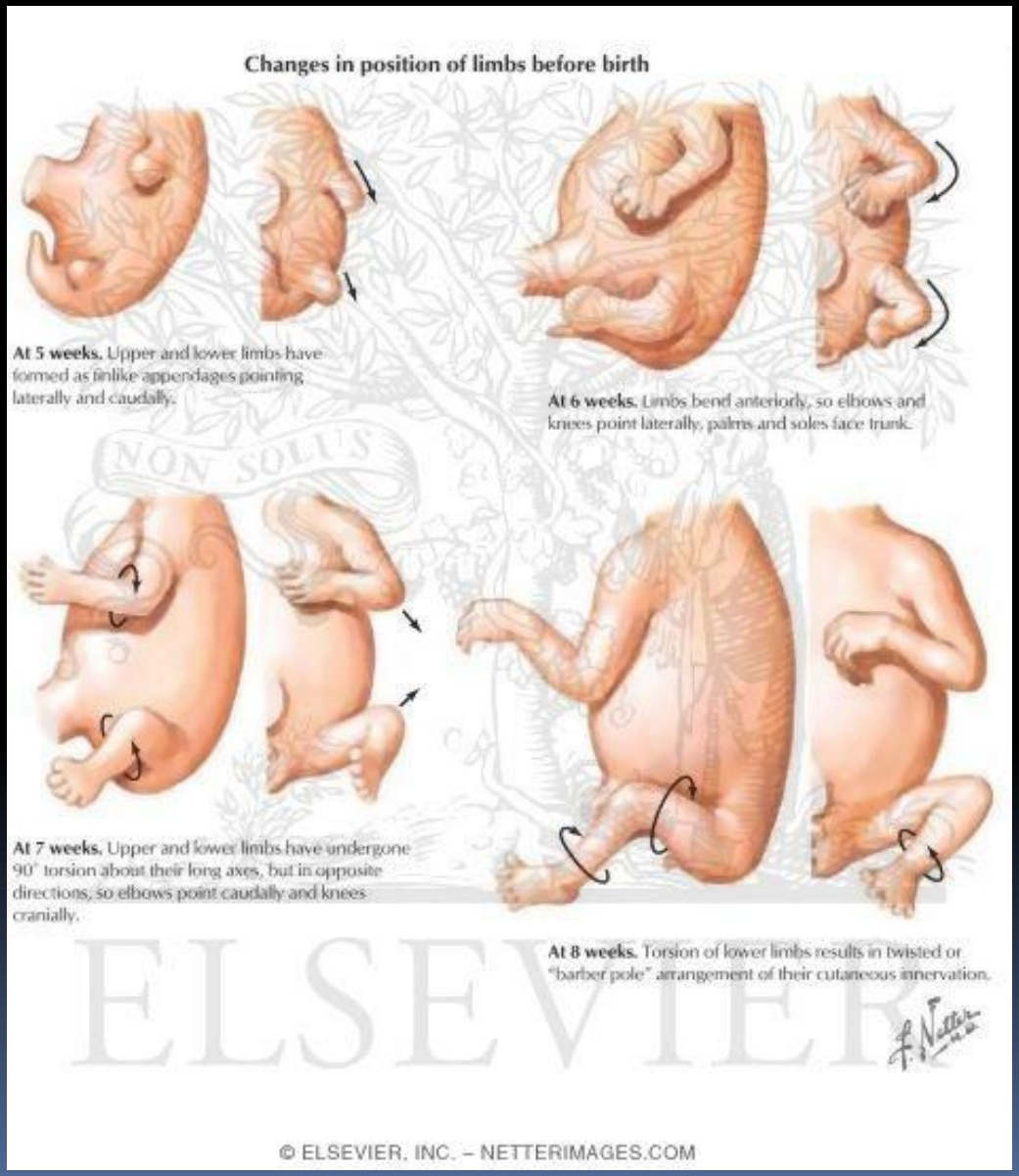

SKELETAL SYSTEM
Thorax and ribs
Jugular notch
Clavicle
7th cervical vertabra
1st thoracic vertebra
Manubrium
Sternal angle
Body
Xiphoid process
Costal cartilage
Costosternal articulation
1
2
3
4
5
6
7
8
9
10
11
12
L1



- SKELETON APPENDICULARE (126 TULANG)
- MEMBRUM INFERIUS = 62 TULANG

  Cingulum = oc coxae = 2 tulang

  Extremitas = femur (2), tibia (2), fibula (2), patella (2) tarsalia (14), metatarsalia (10), phalanx(28) = 60 tulang


Changes in position of limbs before birth
At 5 weeks. Upper and lower limbs have formed as finlike appendages pointing laterally and caudally.
At 6 weeks. Limbs bend anteriorly, so elbows and knees point laterally, palms and soles face trunk.
At 7 weeks. Upper and lower limbs have undergone 90° torsion about their long axes, but in opposite directions, so elbows point caudally and knees cranially.
At 8 weeks. Torsion of lower limbs results in twisted or "barber pole" arrangement of their cutaneous innervation.
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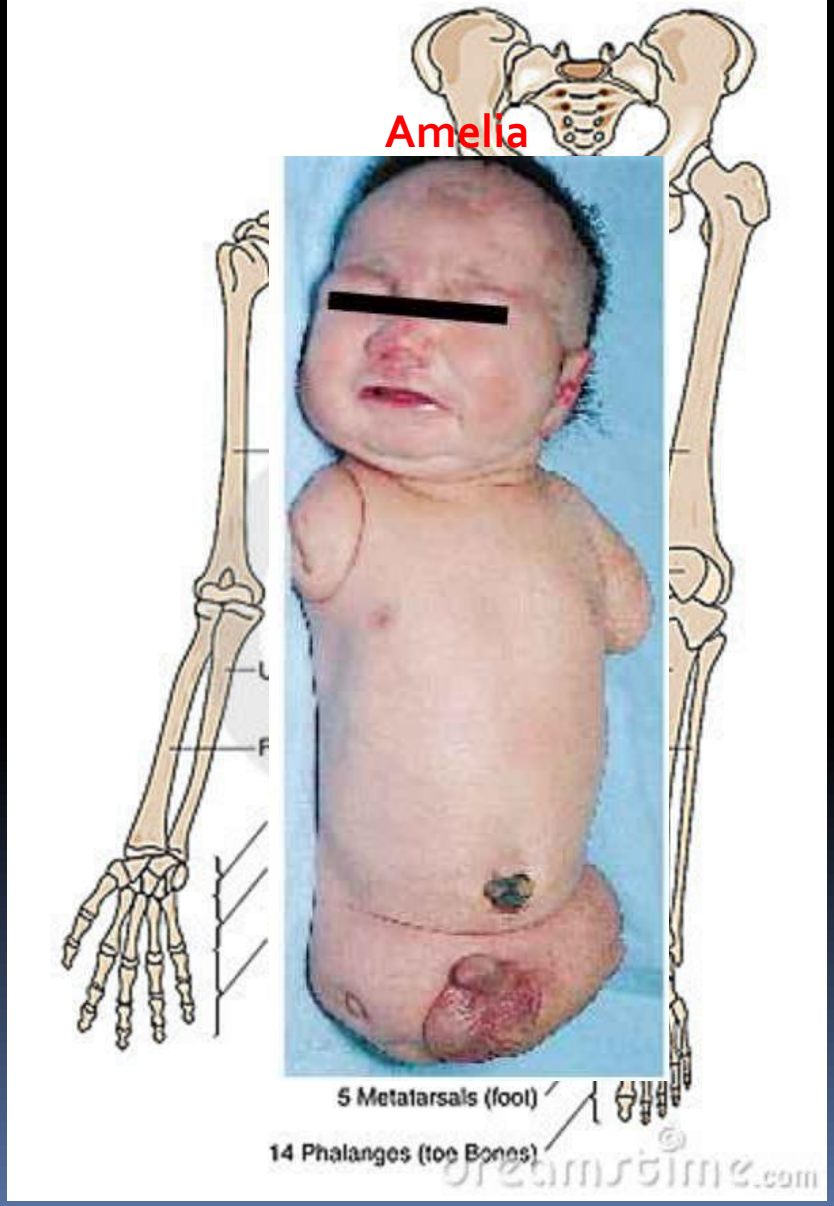
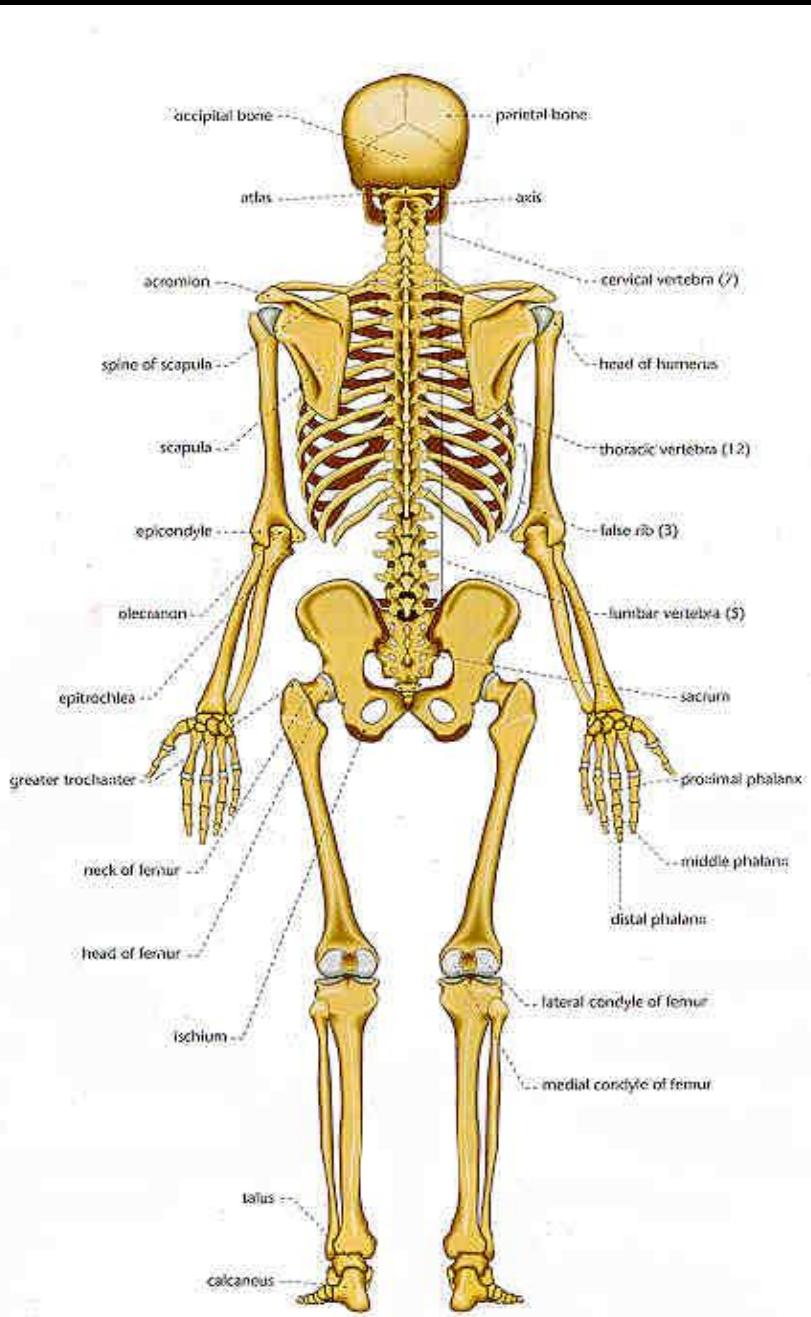

Amelia
5 Metatarsals (foot)
14 Phalanges (toe Bones)



- MEMBRUM SUPERIUS = 64 TULANG

  Cingulum = scapula dan clavicula = 4 tulang

  Extremitas = humerus (2), radius (2), ulna (2),

  carpalia (16), metacarpalia (10) phalanx (28)

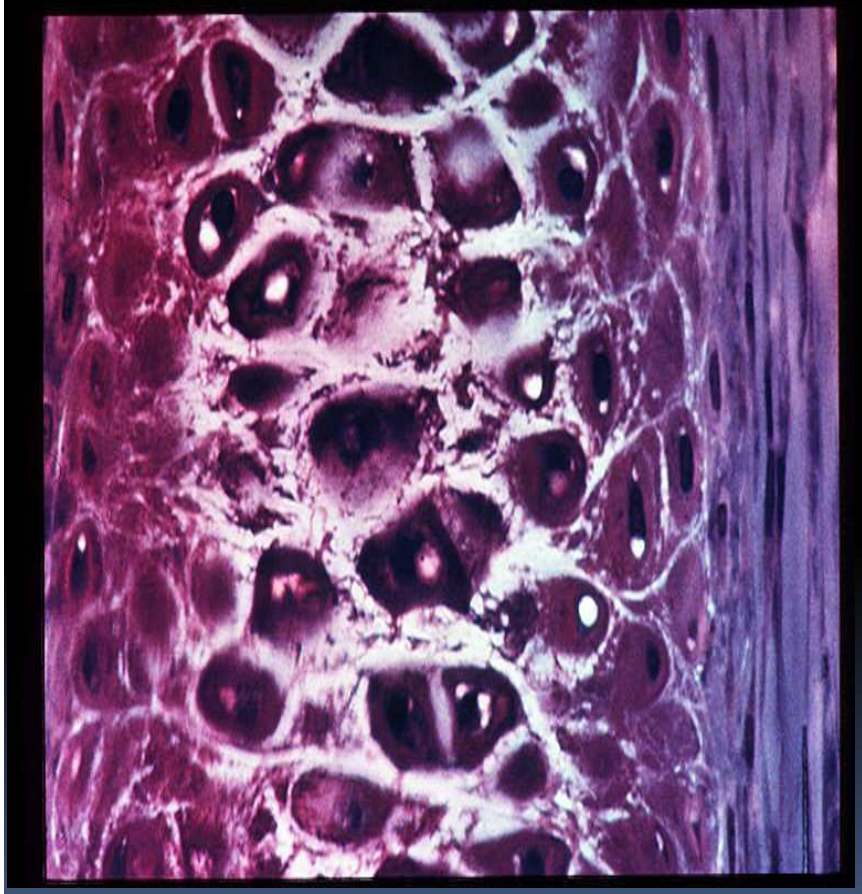
  = 60 tulang

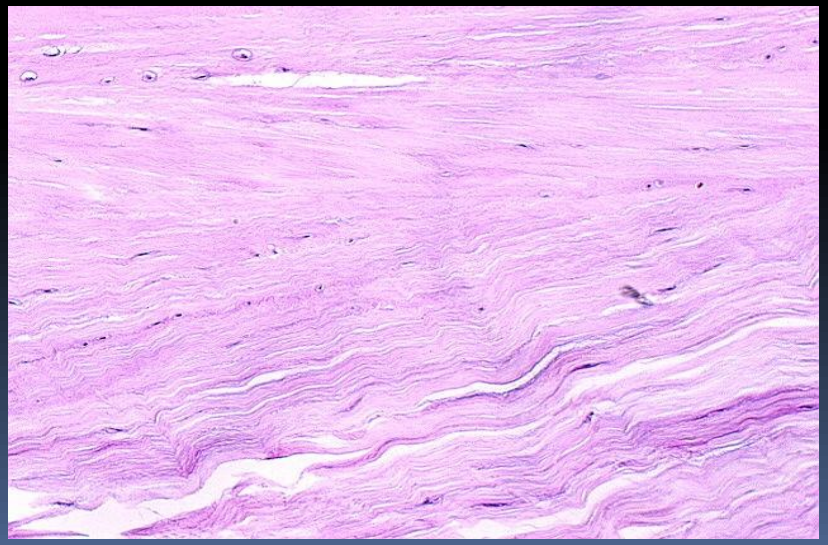
CARTILAGO: jaringan cartilago, model (pra) tulang, penyusun organ, di persendian (sendi diarthrosis - gerak)

Composition:

- Condrocytus, condroblastus (di pericondrium)
- Collagen fibers and elastic (Serabut collagen (tekanan), elastis (regangan)
- Proteoglican matrix (mukopolisakarida): asam sulfat chondroitin, asam hyaluronid
- Avascular & no innervation
- Selubung: pericondrium

Gambaran mikroskopik kartilago (hyalin)





Klasifikasi kartilago

1. Cartilago hyalina

- Banyak dijumpai, dapat menulang
- Cartilago septi nasi, epiglottis, thyroidea, cricoidea, bronchus, cartilago costalis, cartilago articularis, cartilago embryonal, discus epiphysealis
- susunan: condrocytus bergerombol

  matriks jernih-transparan, tembus cahaya

  indeks bias serabut collagen sama dgn matriks

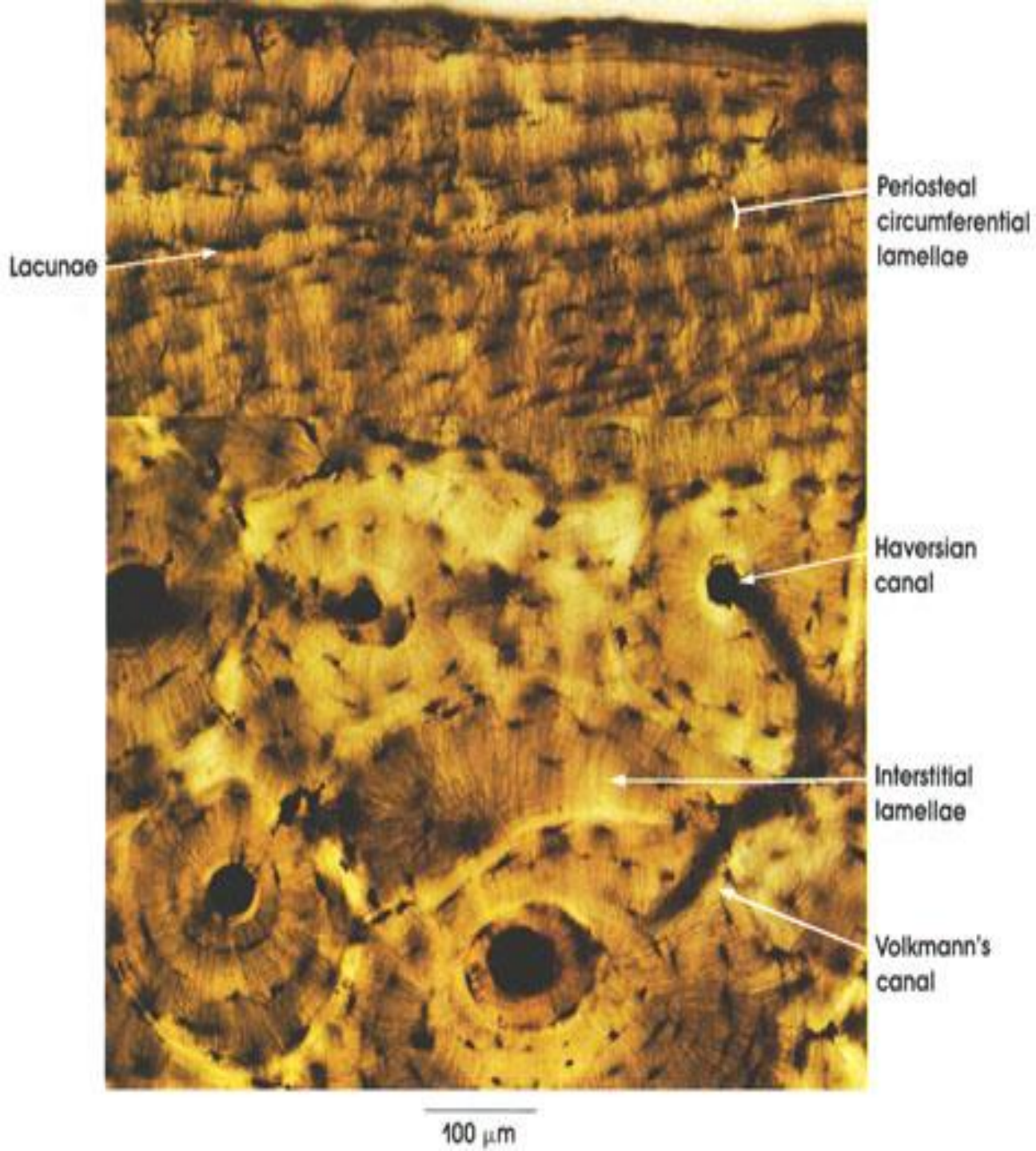
2. Cartilago fibrosa
   - Cartilago articularis temporomandibularis
   - susunan: condrocytus tesebar
   - serabut collagen tampak
3. Cartilago elastica
   - Jarang menulang/kalsifikasi
   - Cartilago auricula, tuba auditiva, cartilago corniculata
   - Susunan: serabut elastis pada matriks

TULANG

- Jaringan hidup, terdiri atas jaringan tulang, saraf, dll.
- Susunan:
- Sel tulang: Osteocytus, Osteoblastus (oeteogenik), Osteoclastus (absorbsi tulang)
- Jaringan interseluler = osteoid Matriks: Hydroxyapatit (glikoprotein) (67%)

  Garam calsium (ca phosphat & carbonat)

  Serabut collagen (33%)

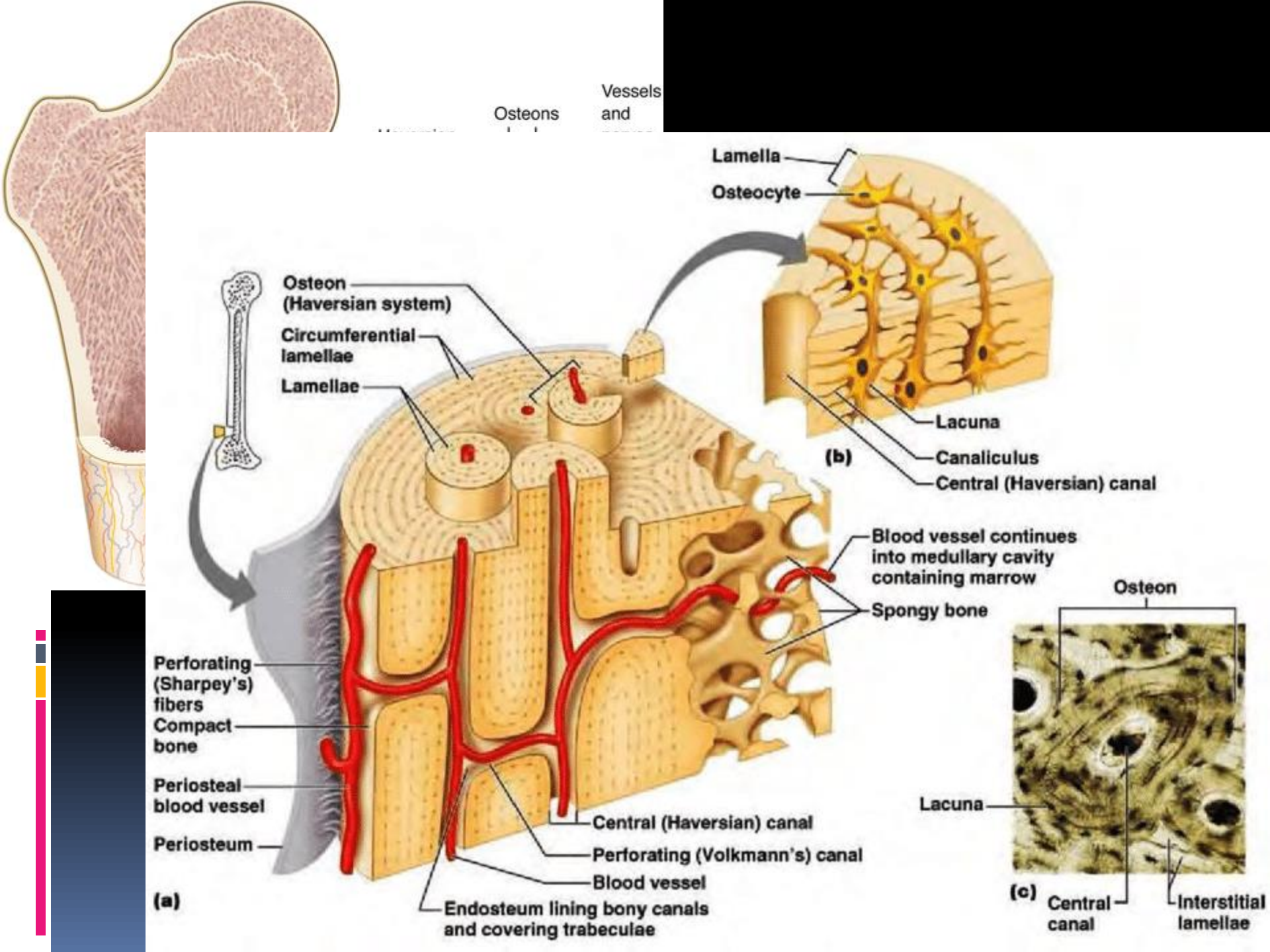

Lacunae
Periosteal circumferential lamellae
Haversian canal
Interstitial lamellae
Volkmann's canal
100 μm

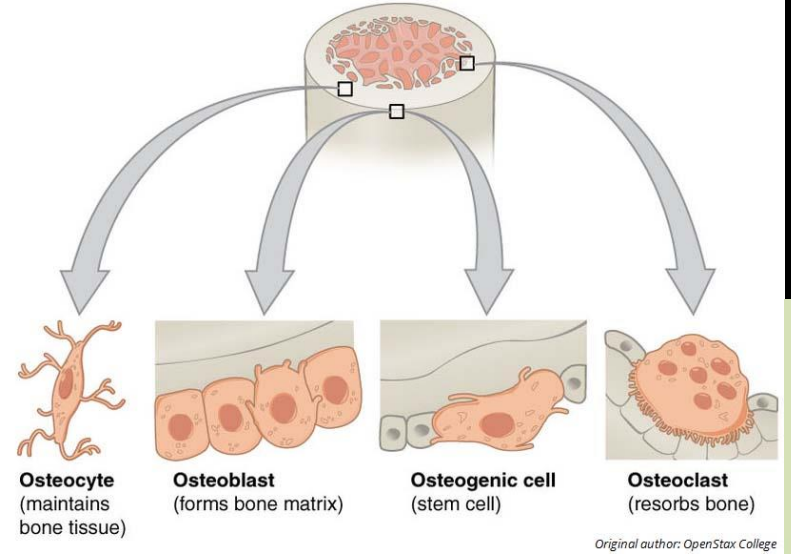
Struktur jaringan tulang

Pola Struktur Compacta

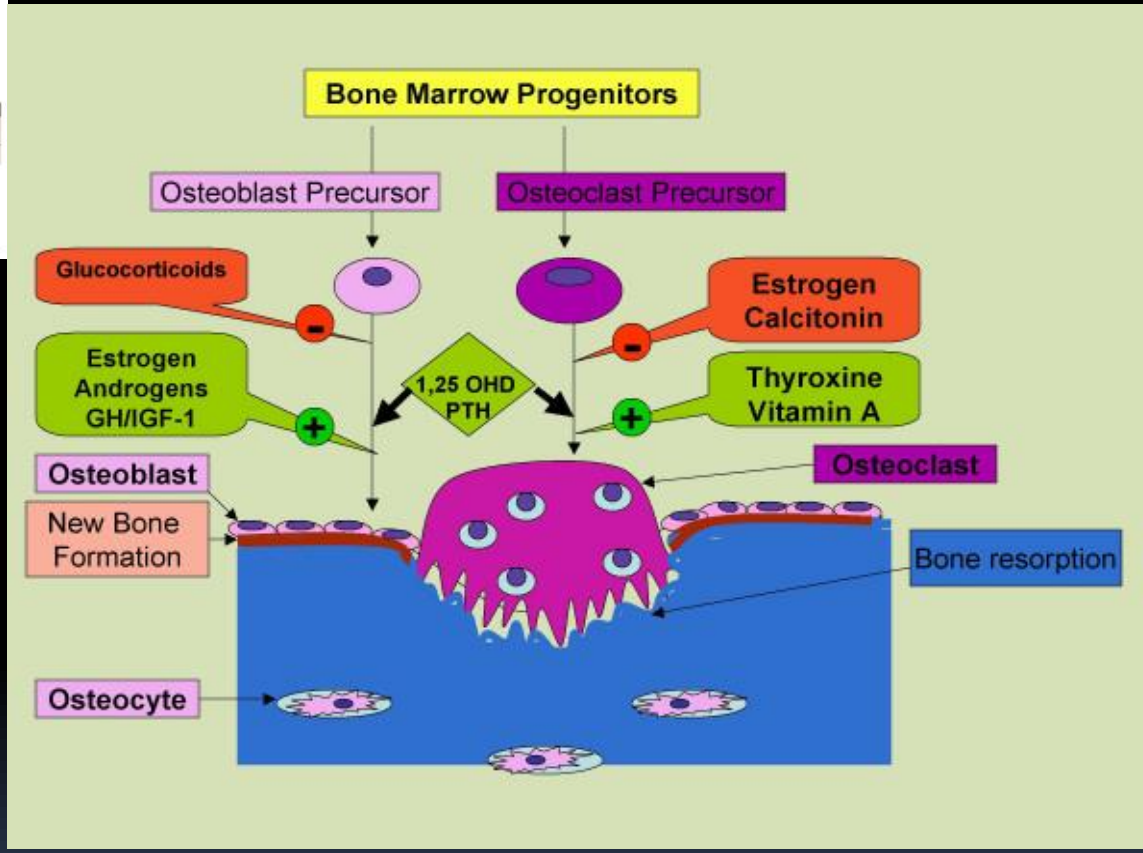
- Struktur tulang keras, lebih berat, kekuatan besar, tak memungkinkan difusi makanan, pembuluh darah ke lacuna, melalui canalis Volkmann, Canalis centralis Haversian dan canaliculi.
- Osteocytus dengan spicula/processus berada di lacuna. Lacuna dikelilingi lamella-lamella

Osteon: canalis centralis, lamella, lacuna, osteocytus &canalicul . Pola silinder di sekeliling canalis centralis


Osteons
Vessels and
Lamella
Osteocyte
Osteon (Haversian system)
Circumferential lamellae
Lamellae
Lacuna
Canaliculus
Central (Haversian) canal
(b)
Blood vessel continues into medullary cavity containing marrow
Spongy bone
Perforating (Sharpey's) fibers
Compact bone
Periosteal blood vessel
Periosteum
Central (Haversian) canal
Perforating (Volkmann's) canal
Blood vessel
Endosteum lining bony canals and covering trabeculae
(a)
Osteon
Lacuna
(c)
Central canal
Interstitial lamellae



Extracellular Matrix
90 – 95 serabut kolagen
Cairan extraseluler dgn proteoglican, chondroitin sulfat
Garam : calcium hidroxiapatit



Calcium regulation

- Hormon parathyroid : Increase blood calcium
- Calcitonin: Reduce blood calcium level
- Vitamin D: Increase calcium absorption, reduce calcium resopstion

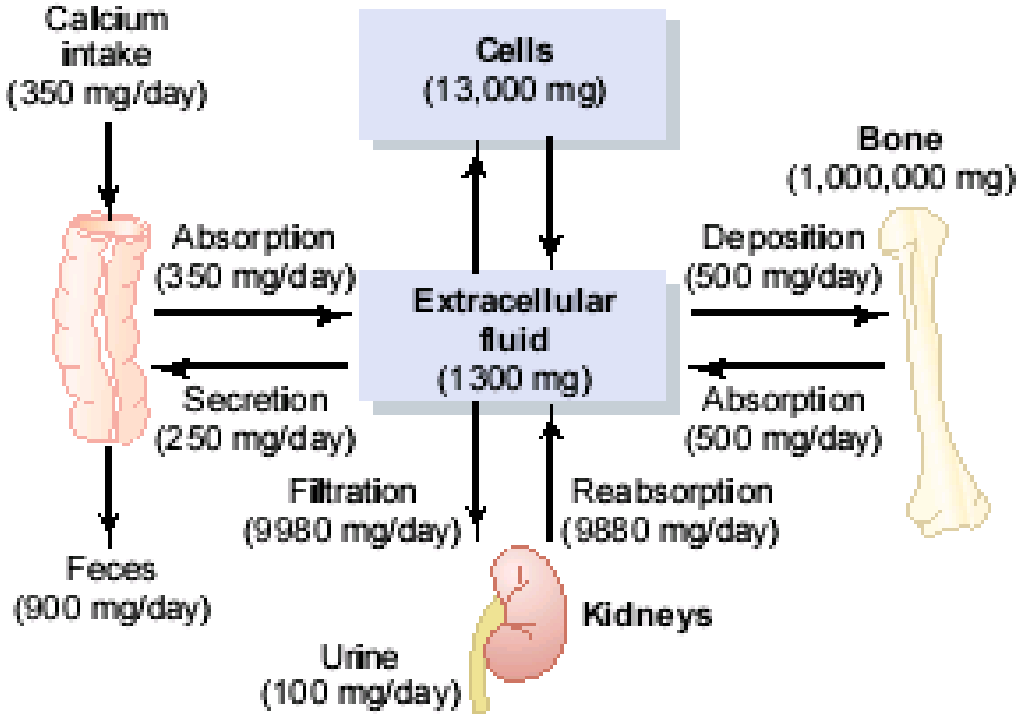
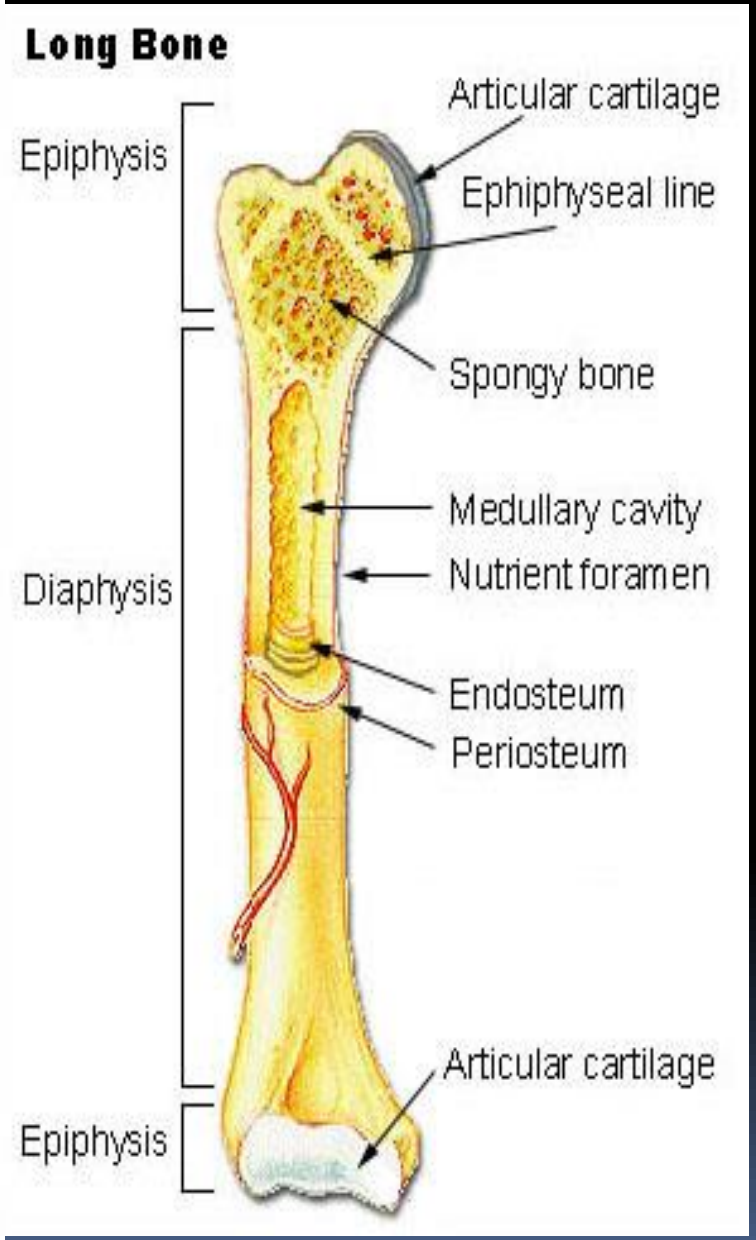


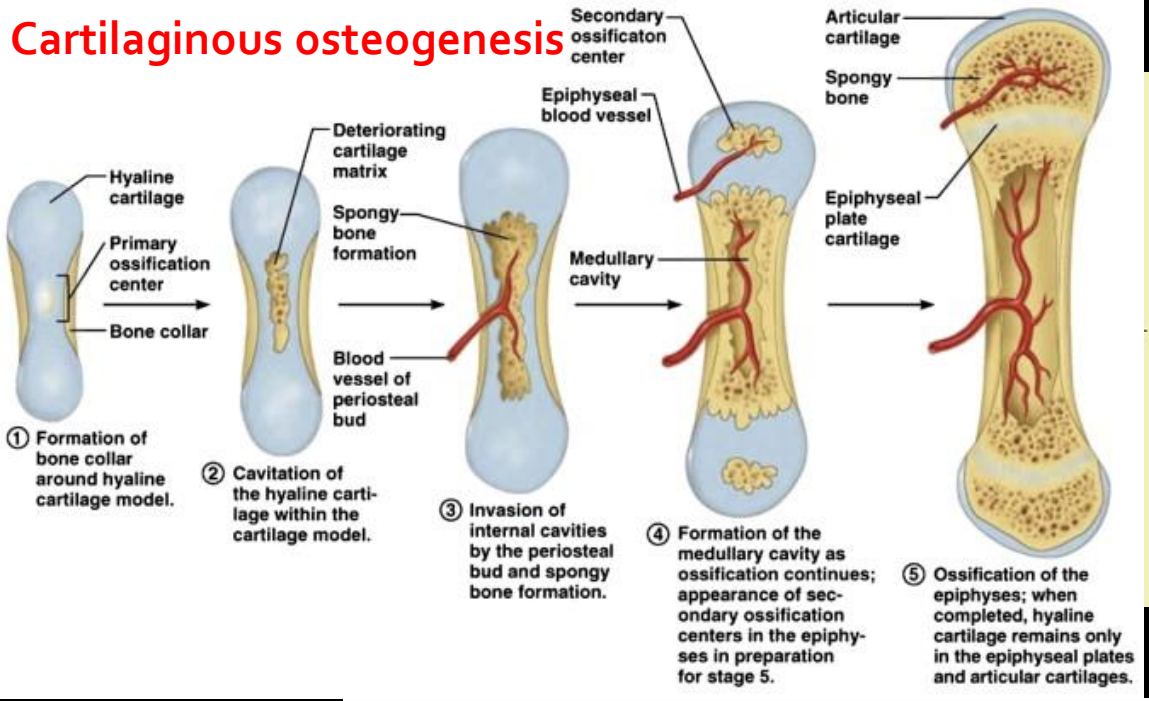
Figure 79–3

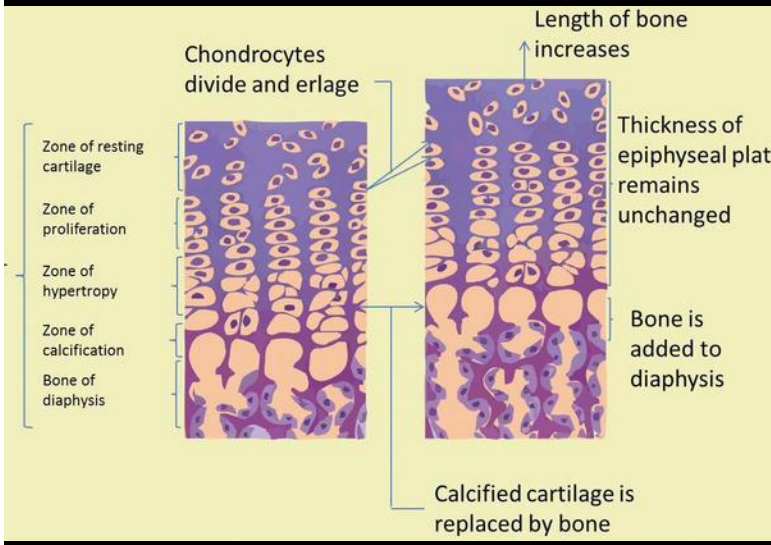
Overview of calcium exchange between different tissue compartments in a person ingesting 1000 mg of calcium per day. Note that most of the ingested calcium is normally eliminated in the feces, although the kidneys have the capacity to excrete large amounts by reducing tubular reabsorption of calcium.



- Pola struktur trabecular (spongiosa)
- Struktur lembaran-lembaran bercabang-cabang dengan ruang diisi sumsum tulang, pola susunan lembaran- lembaran mencerminkan kekuatan yang melalui tulang

Cartilaginous osteogenesis





Intramembranous osteogenesis

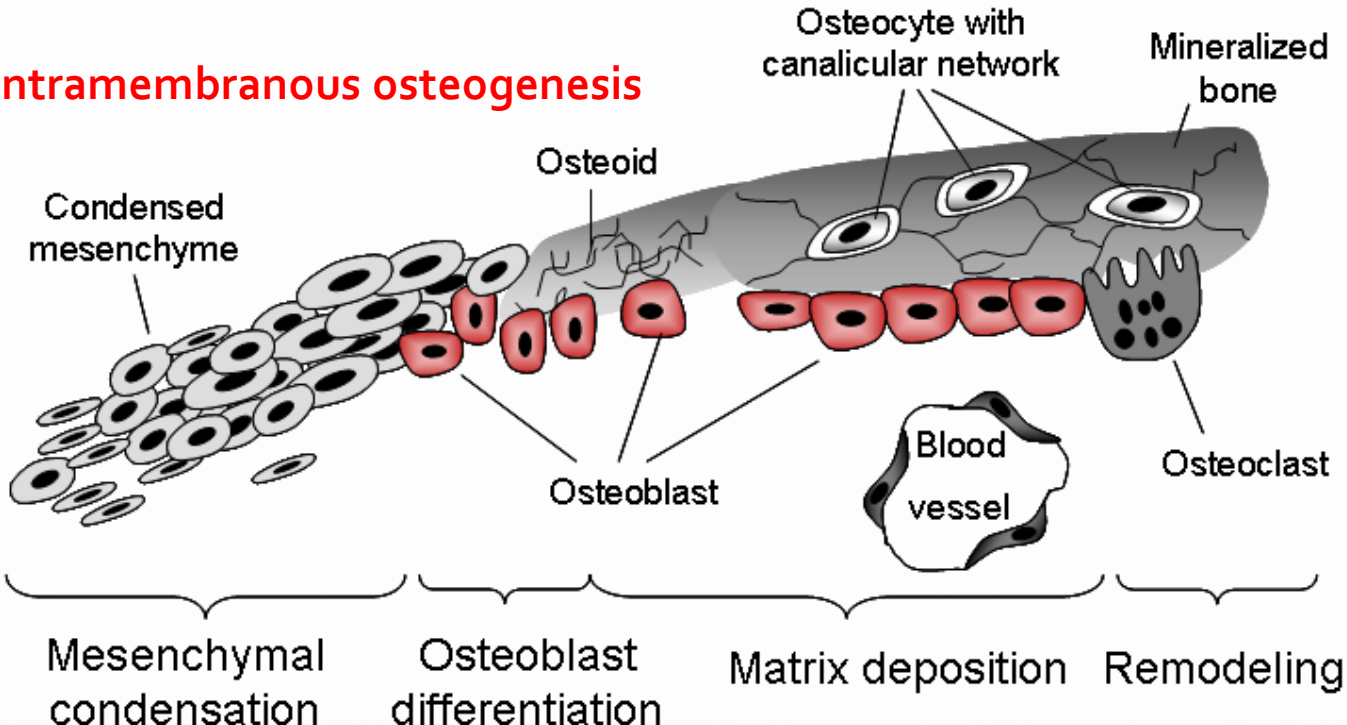


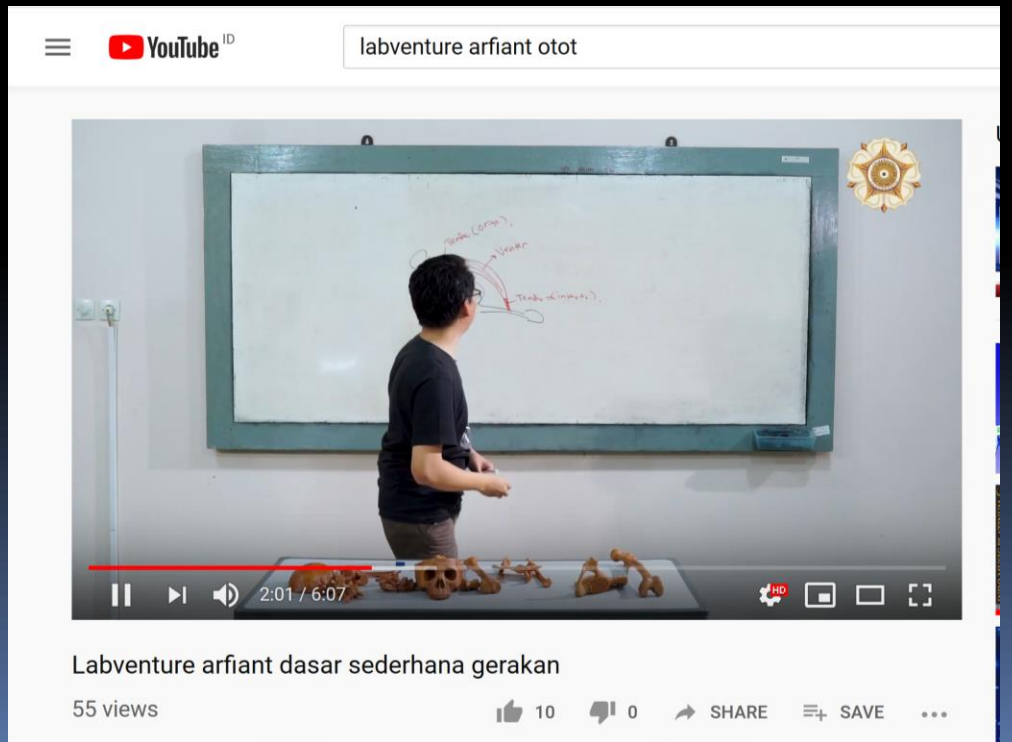
Photo courtesy of Virginia Commonwealth University, Department of Pathology, neuropathology minicourse Web site. Used with permission.

Figure 7.12 Achondroplastic Dwarfism. The student on the *right*, pictured with her roommate of normal height, is an achondroplastic dwarf with a height of about 122 cm (48 in.). Her parents were of normal height. Note the normal proportion of head to trunk but shortening of the limbs.

Movement in locomotor system

- Pulling
- No movement without joint or articulation
- Articulation: Connection between 2 bones regardless (with or without) to the movement

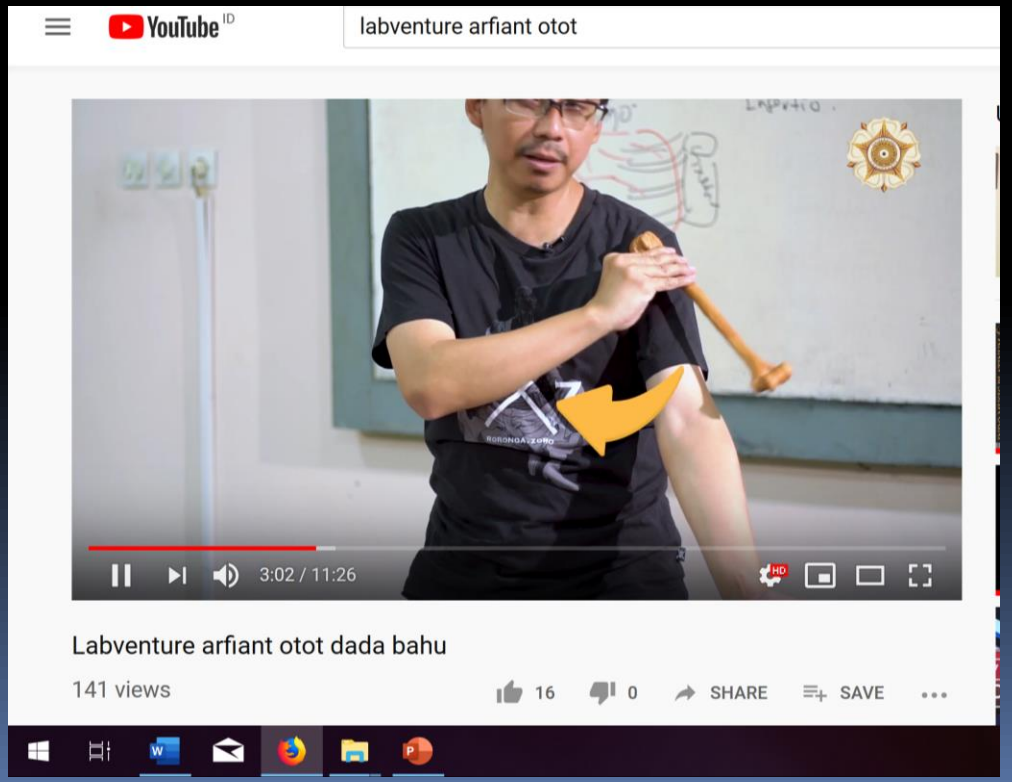
https://www.youtube.com/watch?v=6Fpl3rODxSo&t=123s



ARTICULATIO

- Sendi, arthrosis, joints, junction
- Connection between skeletal components (oss/cartilago)
- Passive movement
- Arthrology

https://www.youtube.com/watch?v=uYwOfQ602eg&t=58s



CLASSIFICATION

BASED ON THE MOVEMENT

1. **Synarthrosis : IMPOSSIBLE TO MOVE**
2. **Amphiarthrosis: ANY MOVEMENT**
3. **Diartrosis: FREE MOVEMENT**

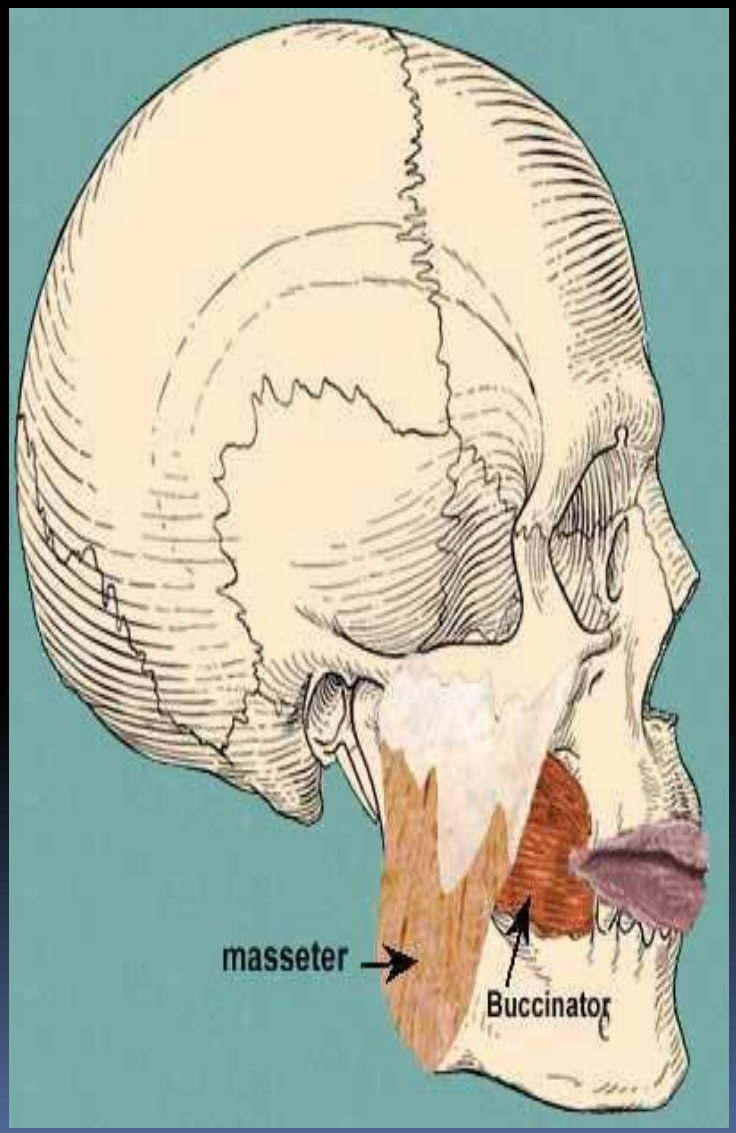
BASED ON CONNECTIVE TISSUE THAT CONNECTS THE BONES

1. **Articulatio fibrosa : Fibrous tissue**
2. **Articulatio cartilaginea : cartilage**
3. **Articulatio synovialis : cavity between component**

Articulatio fibrosa

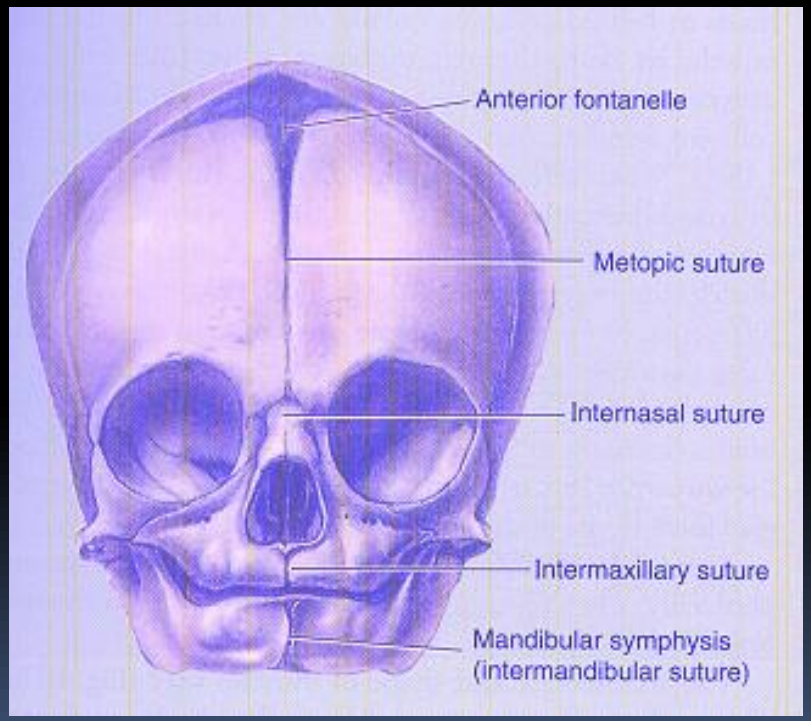
- The amount of movement occurring at a fibrous joint depends in most cases on the length of the fibers uniting the articulating bones
  - **Sutura**
  - **Syndesmosis**
  - **Gomphosis**

Articulation in cranium



Sutura

- Connected by fibrous tissue
- Collagen band, not hard
- Ossify : synostosis
- Seen in calvaria cranii, irregular bone surface
- Sutura coronaria, sutura sagitalis, dll.


Anterior fontanelle
Metopic suture
Internasal suture
Intermaxillary suture
Mandibular symphysis
(intermandibular suture)

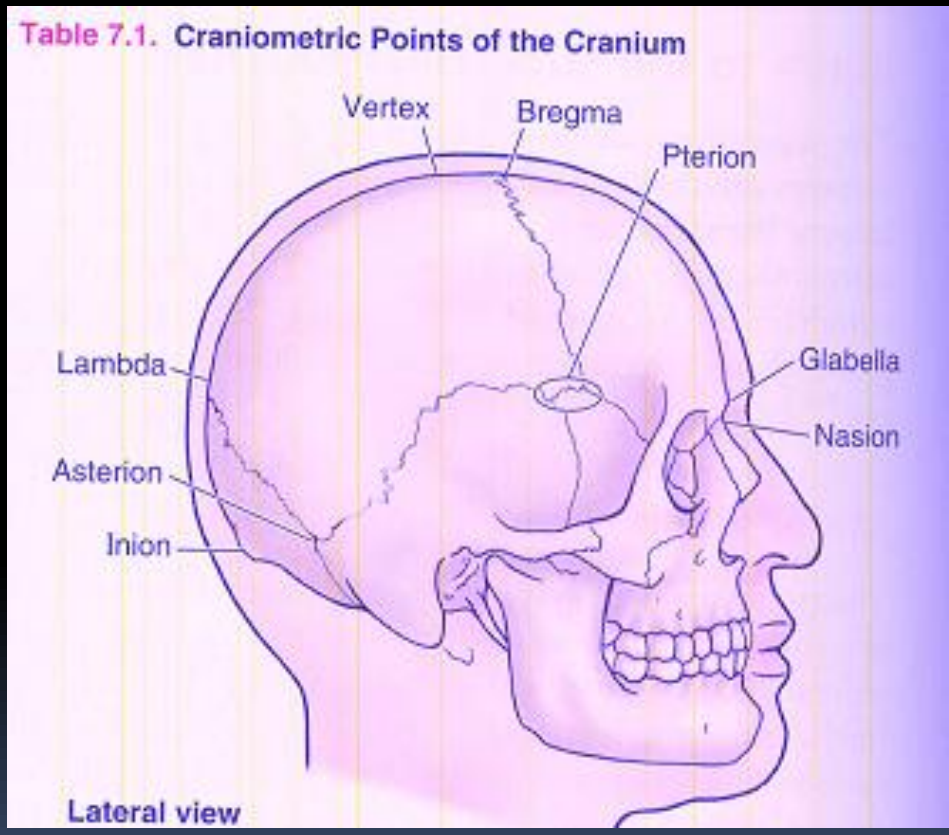
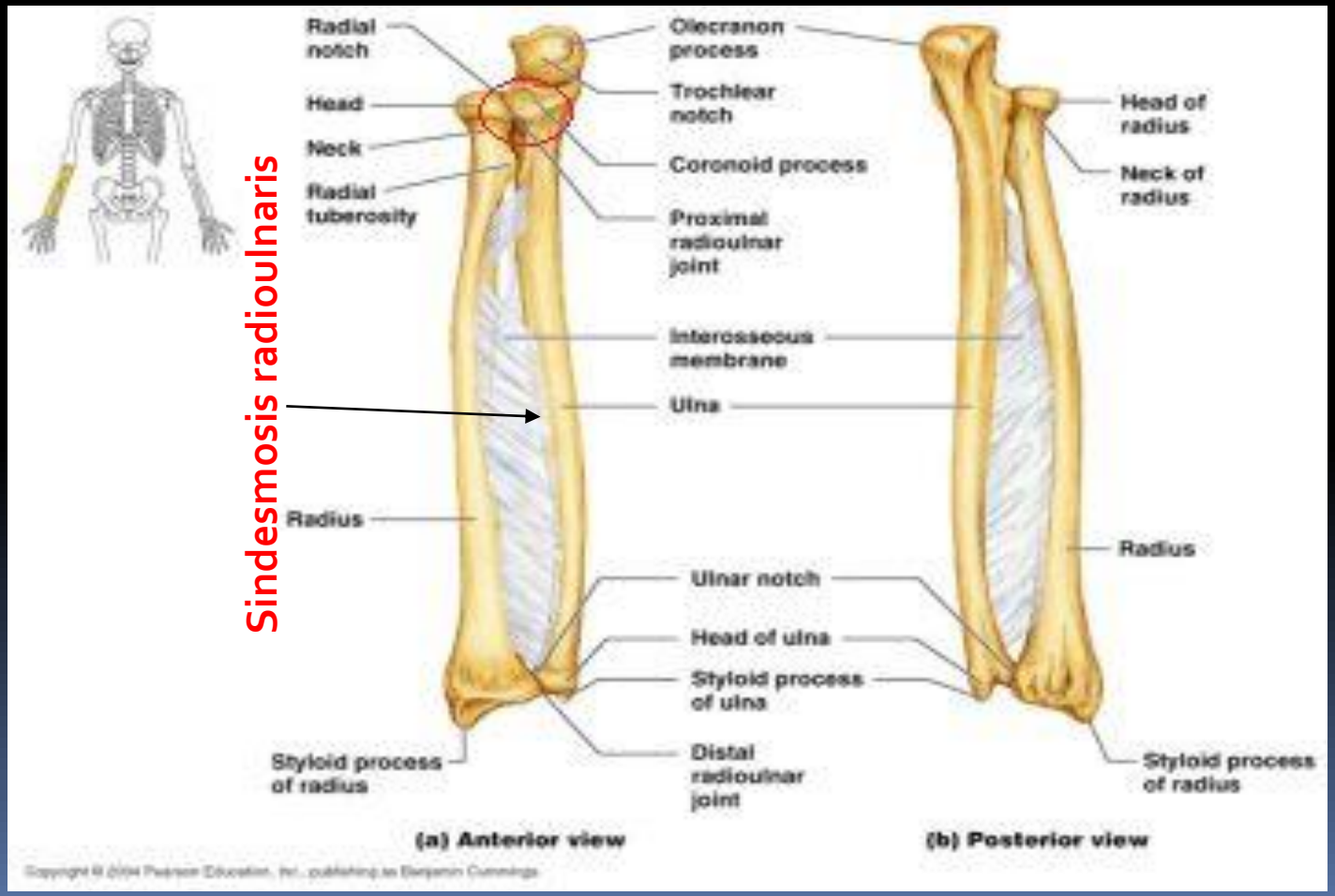


Table 7.1. Craniometric Points of the Cranium
Vertex
Bregma
Pterion
Lambda
Glabella
Nasion
Asterion
Inion
Lateral view

Syndesmosis

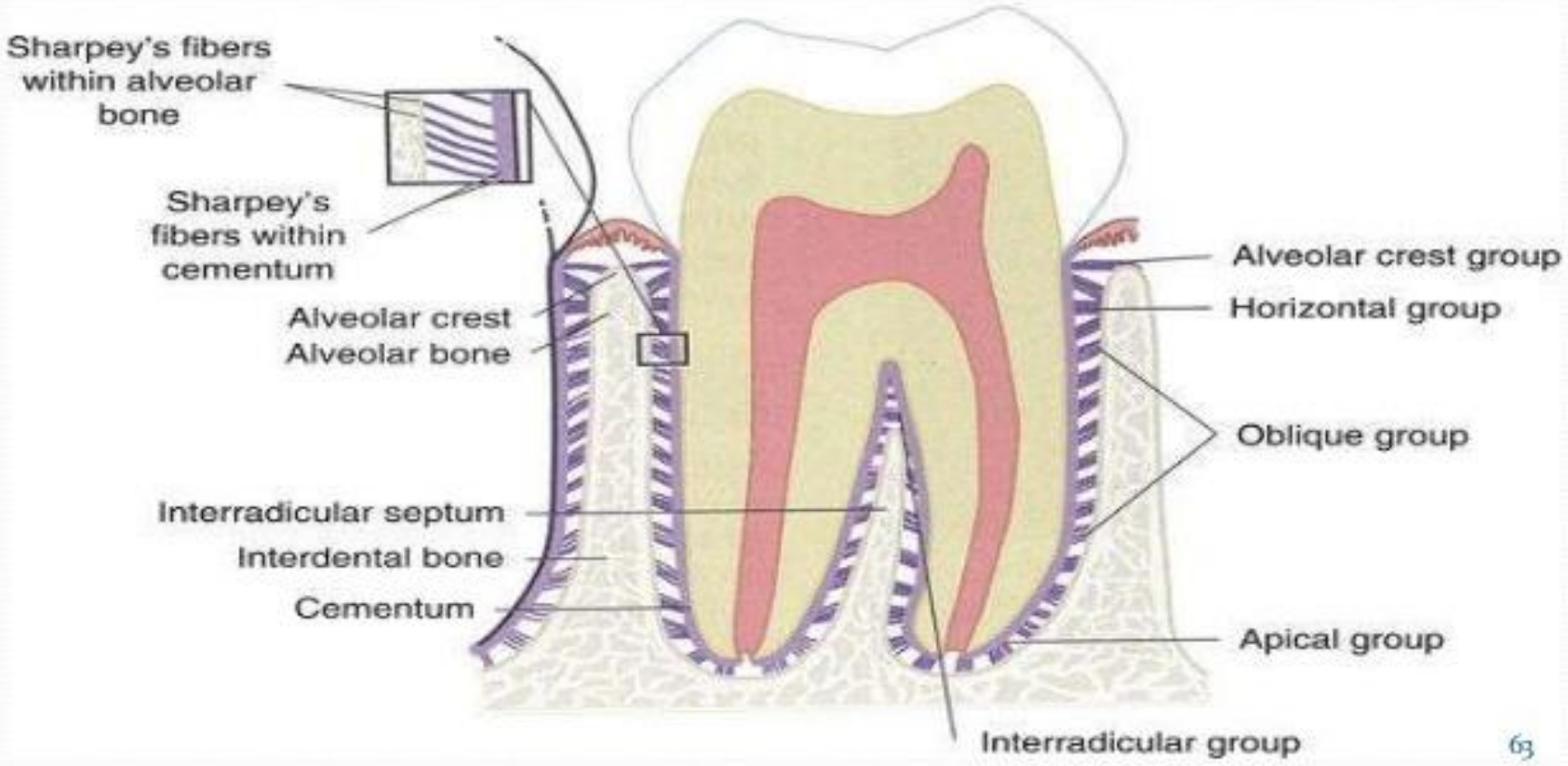
- unites the bones with a sheet of fibrous tissue, either a ligament or a fibrous membrane
- partially movable
  - **- Membrana interossea, syndesmosis tibiofibularis inferior/distalis**

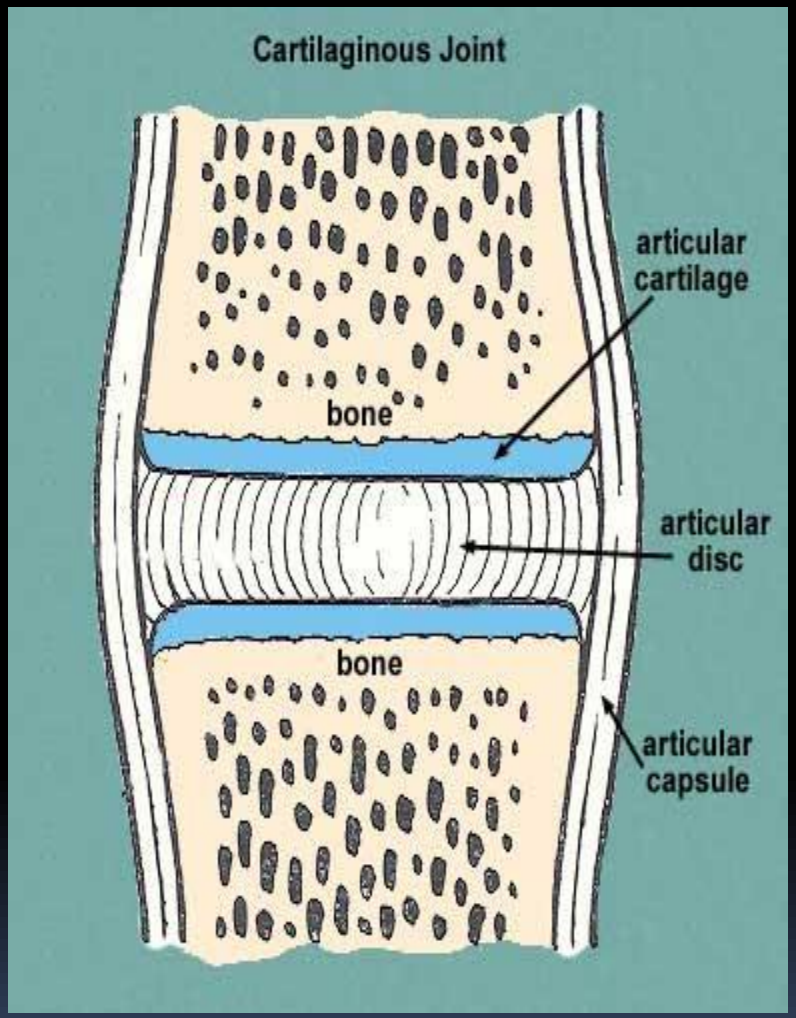


Gomphosis

- **Articulation between teeth and alveolus (dentoalveolar syndesmosis)**
- a fibrous joint in which a peg like process fits into a socket
- articulation between the root of the tooth and the alveolar process o f the jaw
- **Movable = pathological process**
- **Connected by lig. periodentale**

PERIODONTAL LIGAMENT FIBERS





- Articulatio cartilaginea
  - Articulatio cartilaginea primer / synchondrosis
  - Articulatio cartilaginea sekunder / symphysis

primary cartilaginous joints, or synchondroses

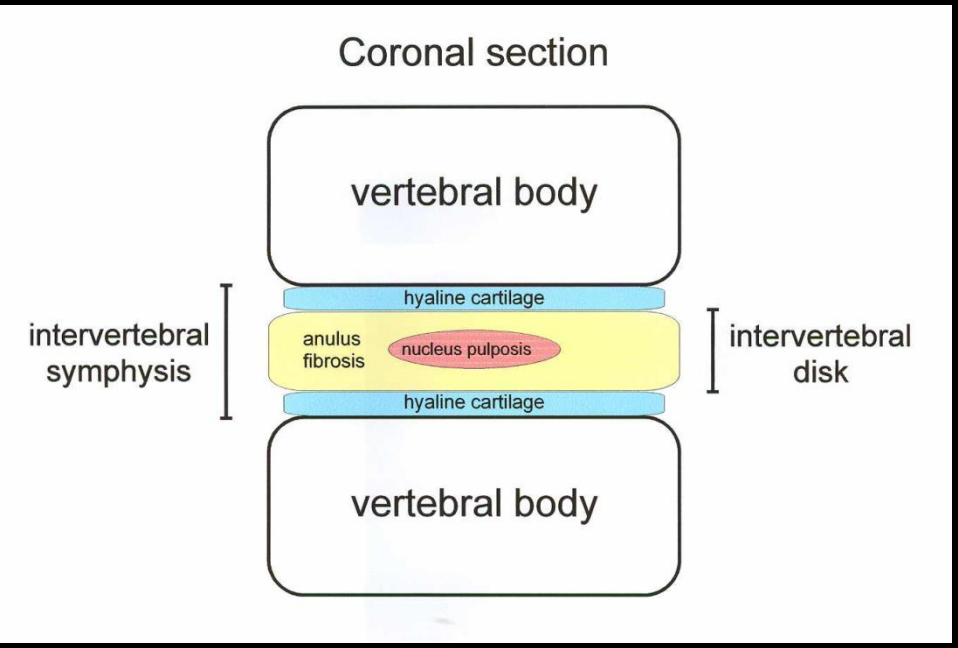
- are united by Hyaline cartilage which permits slight bending during early life.
- Primary cartilaginous joints are usually temporary unions, such as those present during the development of a long bone
- **Become synostosis, no motion**
- **Discus epiphysialis, synchondrosis sphenooccipitalis, synchondrosis manubriosternalis**

Secondary cartilaginous joints, or symphysis,

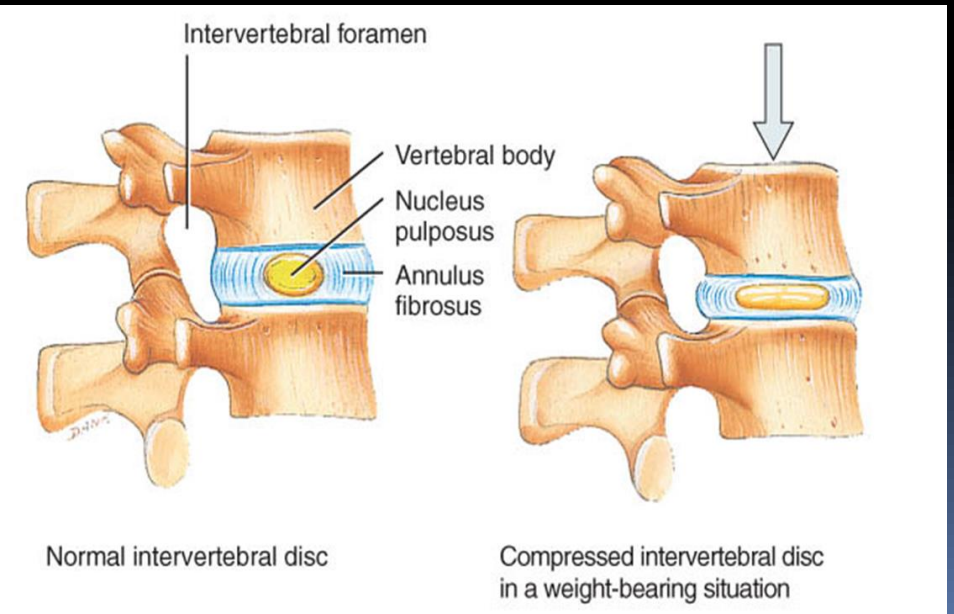
- strong, slightly movable joints united by fibrocartilage tissue.
- Discus interuertebralis

Symphysis

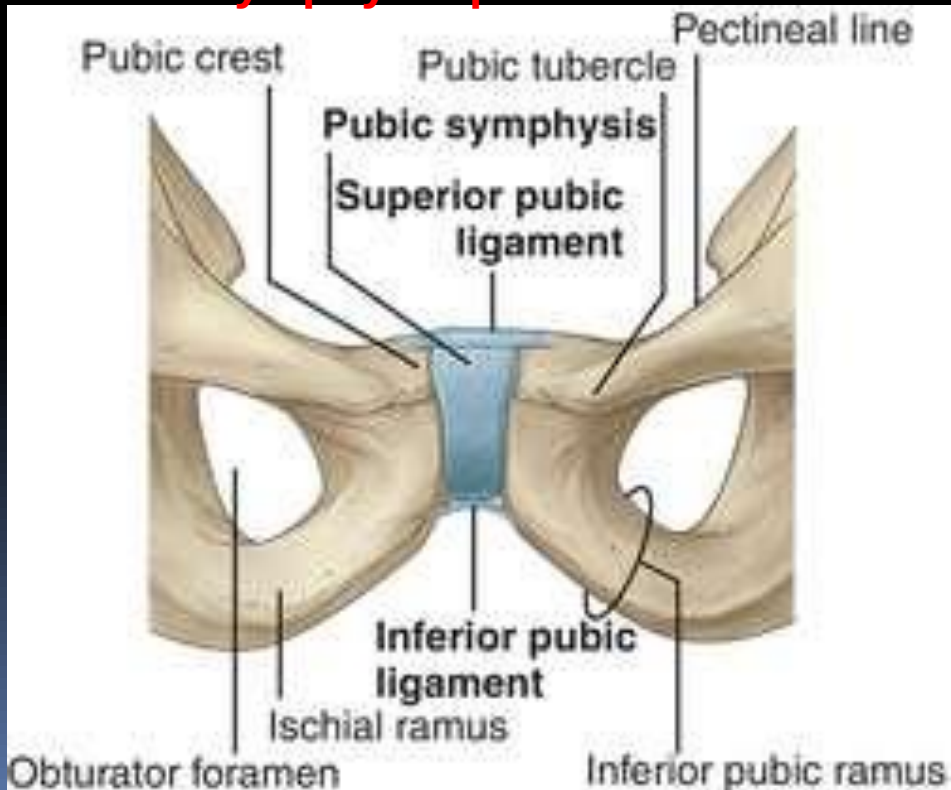
Discus intervertebralis



- Fused by fibrocartilaginea,
-cartilage mass with collagen
-little movement



Symphysis pubis



Articulatio synovialis (diarthrosis)

- Sendi
- Free movement : Diarthrosis
- Characteristic :

  - **Cavitas synovialis**

  - **Cartilago articularis (non calcification, avascular, transmit load and reduce friction)**

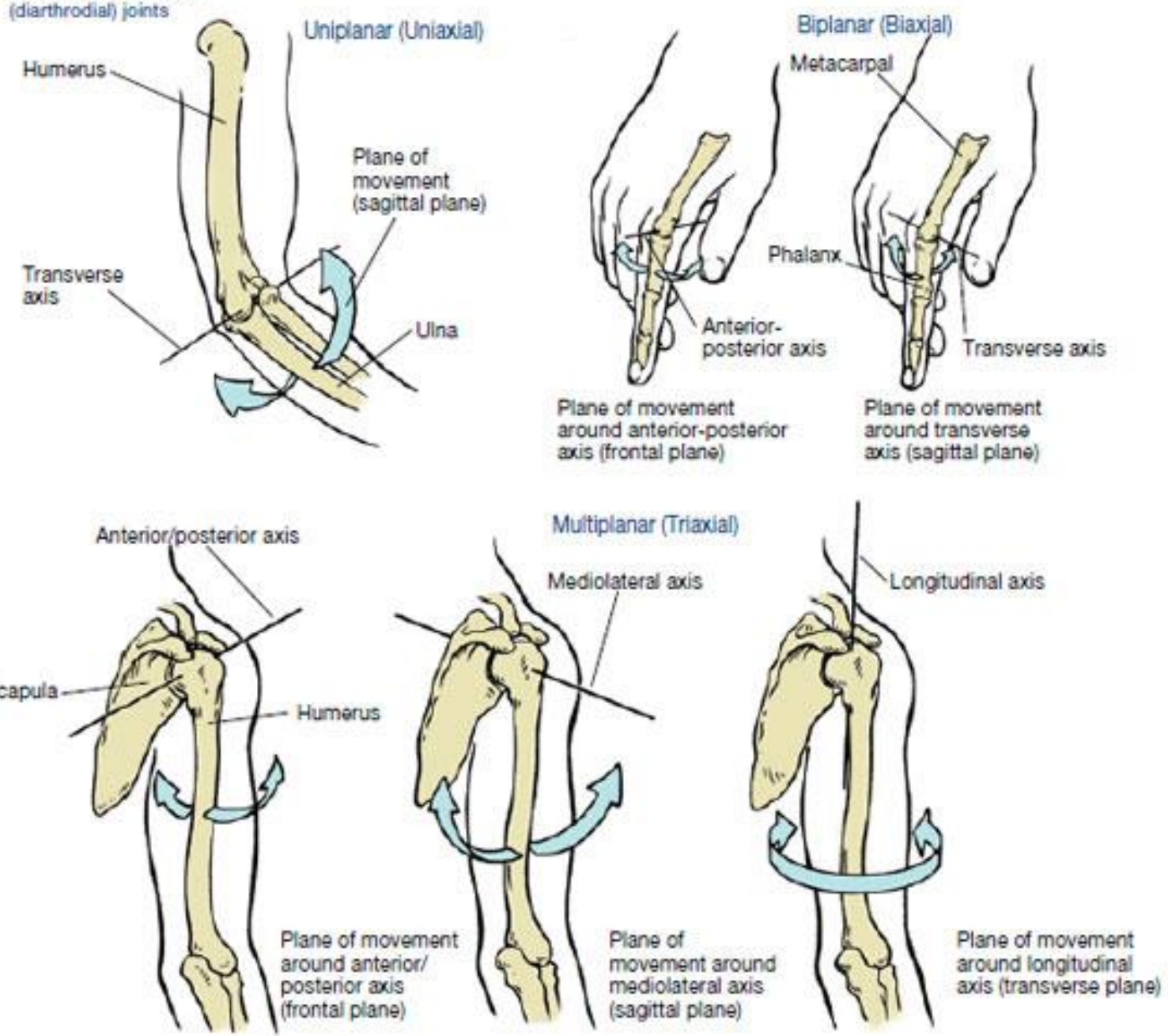
  - **Membrana synovialis (vascularisasi baik)**

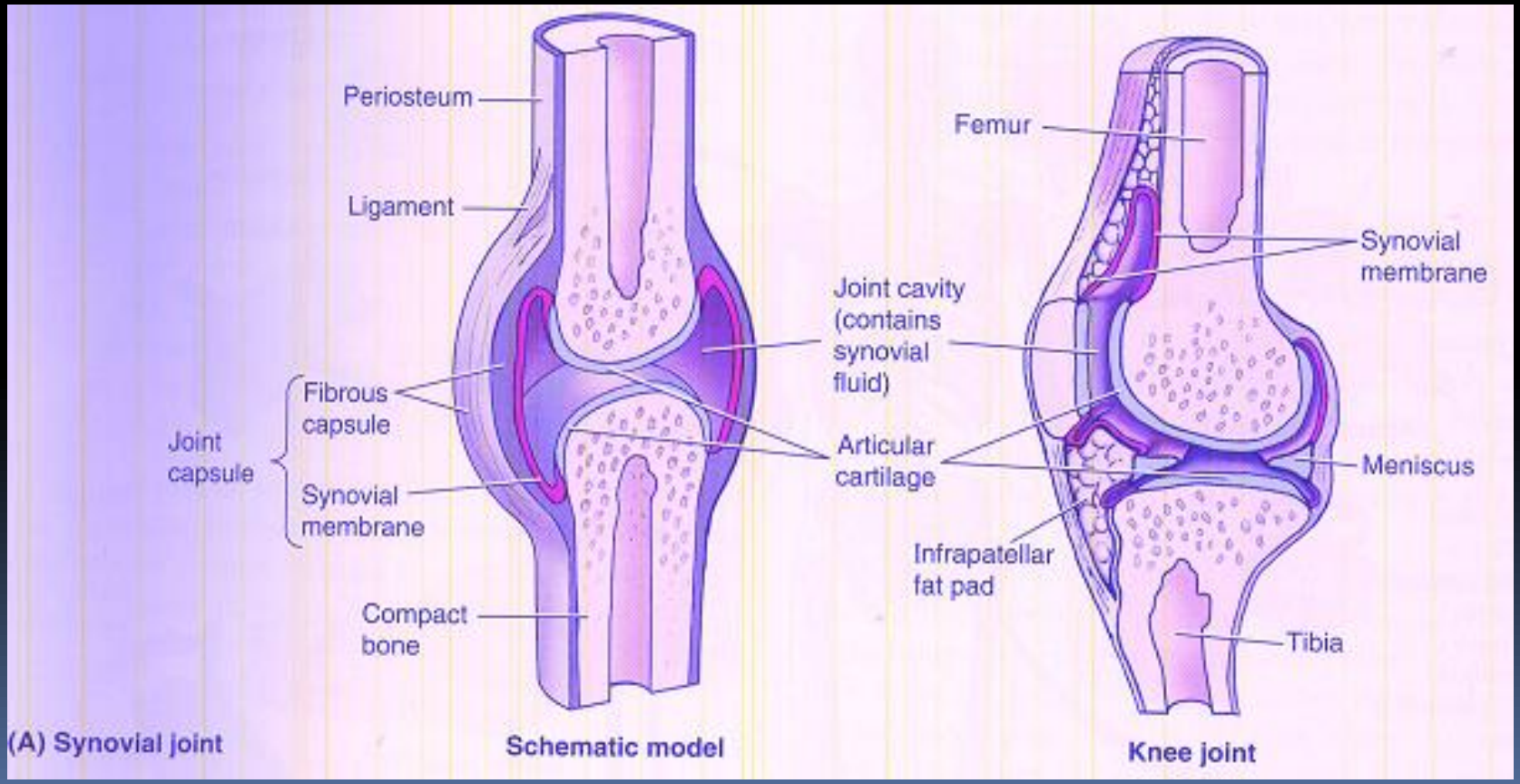
  - **Capsula articularis**

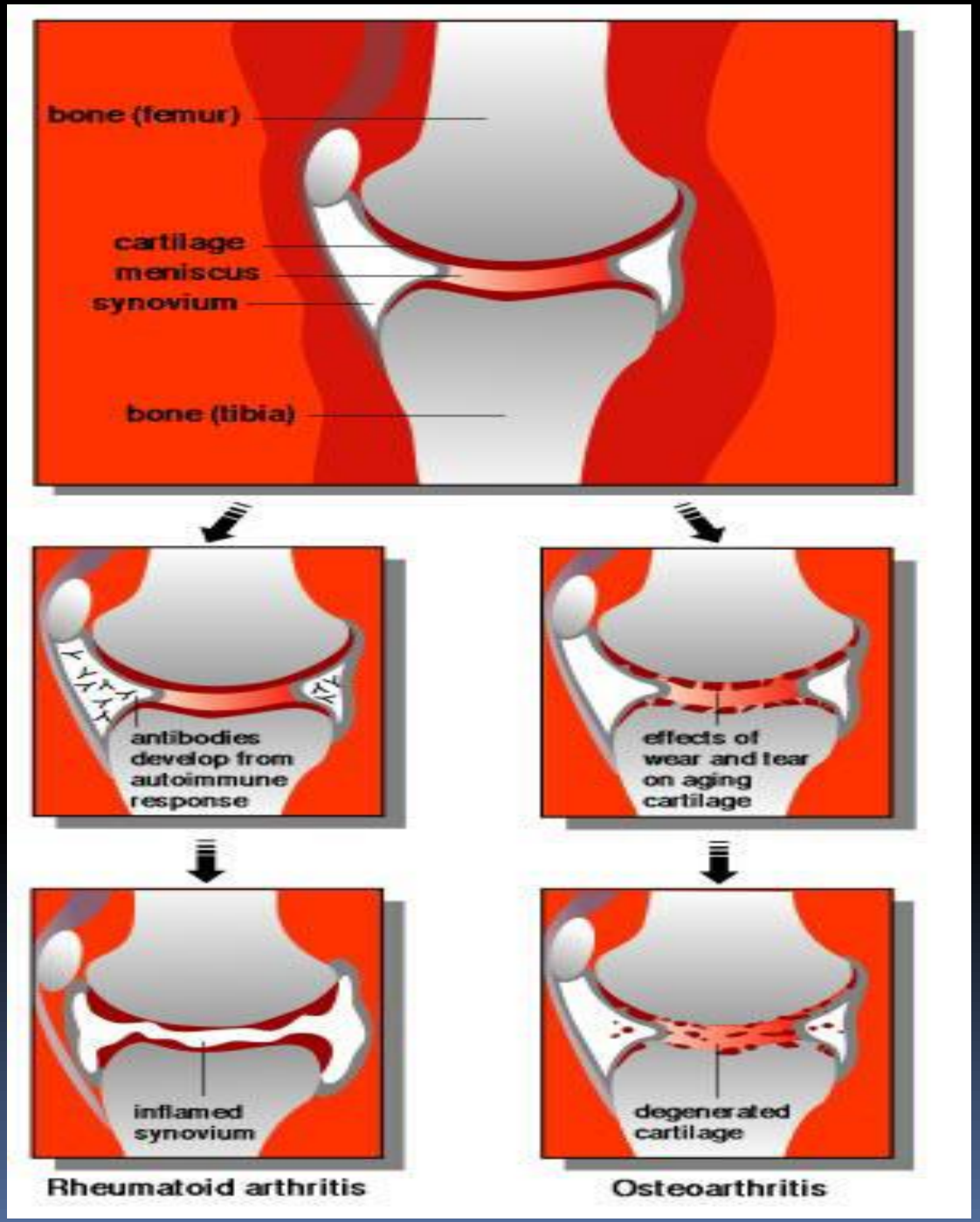
three axes of rotation

- Joints rotate in these axes, allowing movement to occur in the planes.
- the anterior-posterior axis (sagital)
  - Abduksi-adduksi,
- the mediolateral axis (transversa / frontal)
  - Fleksi-ekstensi
- the longitudinal axis
  - Endorotasi-eksorotasi
- **Axis : uniaxial, biaxial, multiaxial**
  Axis transversal – flexi & extensi
  Axis longitudinal – rotasi
  Axis sagittal – abduksi & adduksi

Figure 1-10
Movement of synovial (diarthrodial) joints

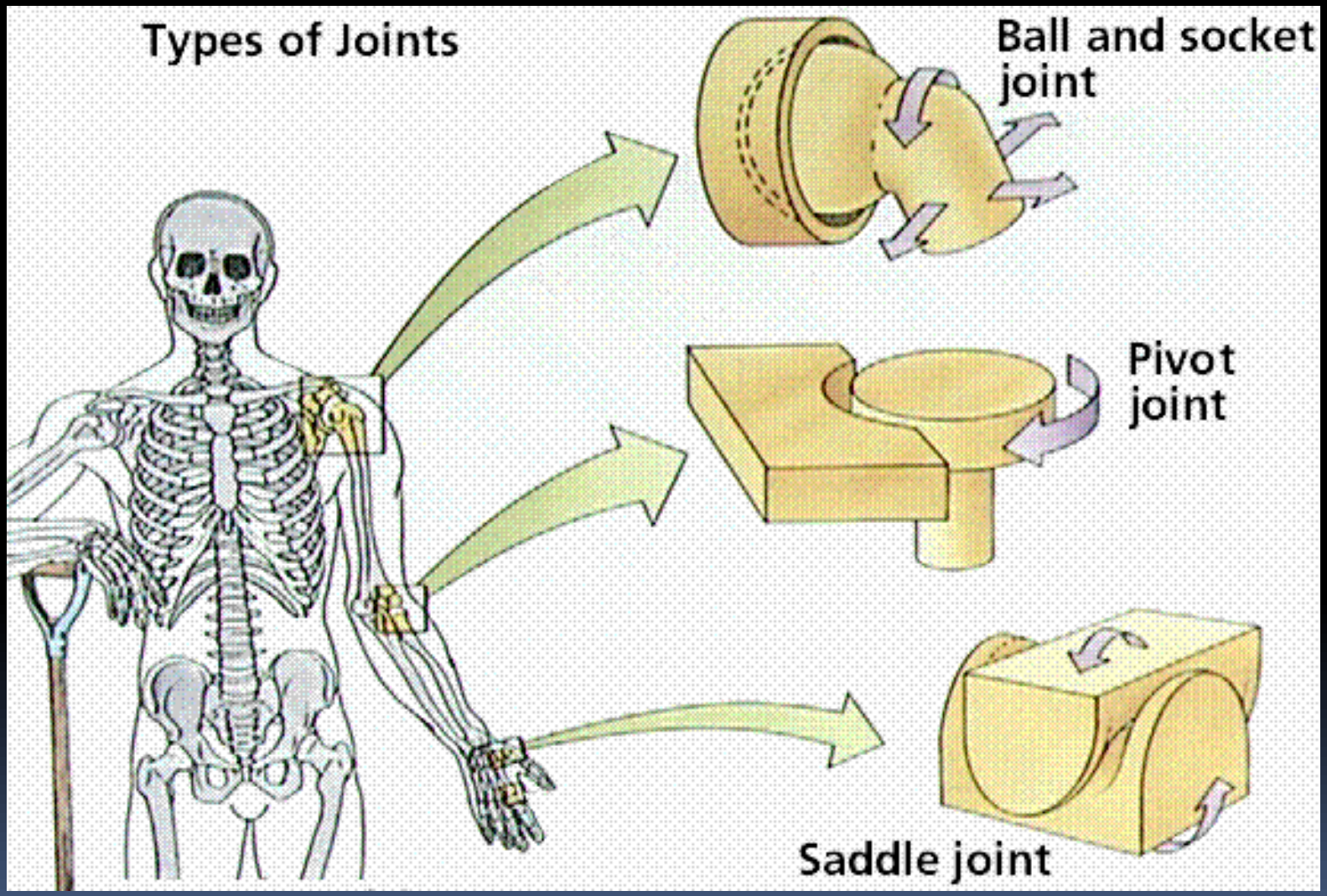


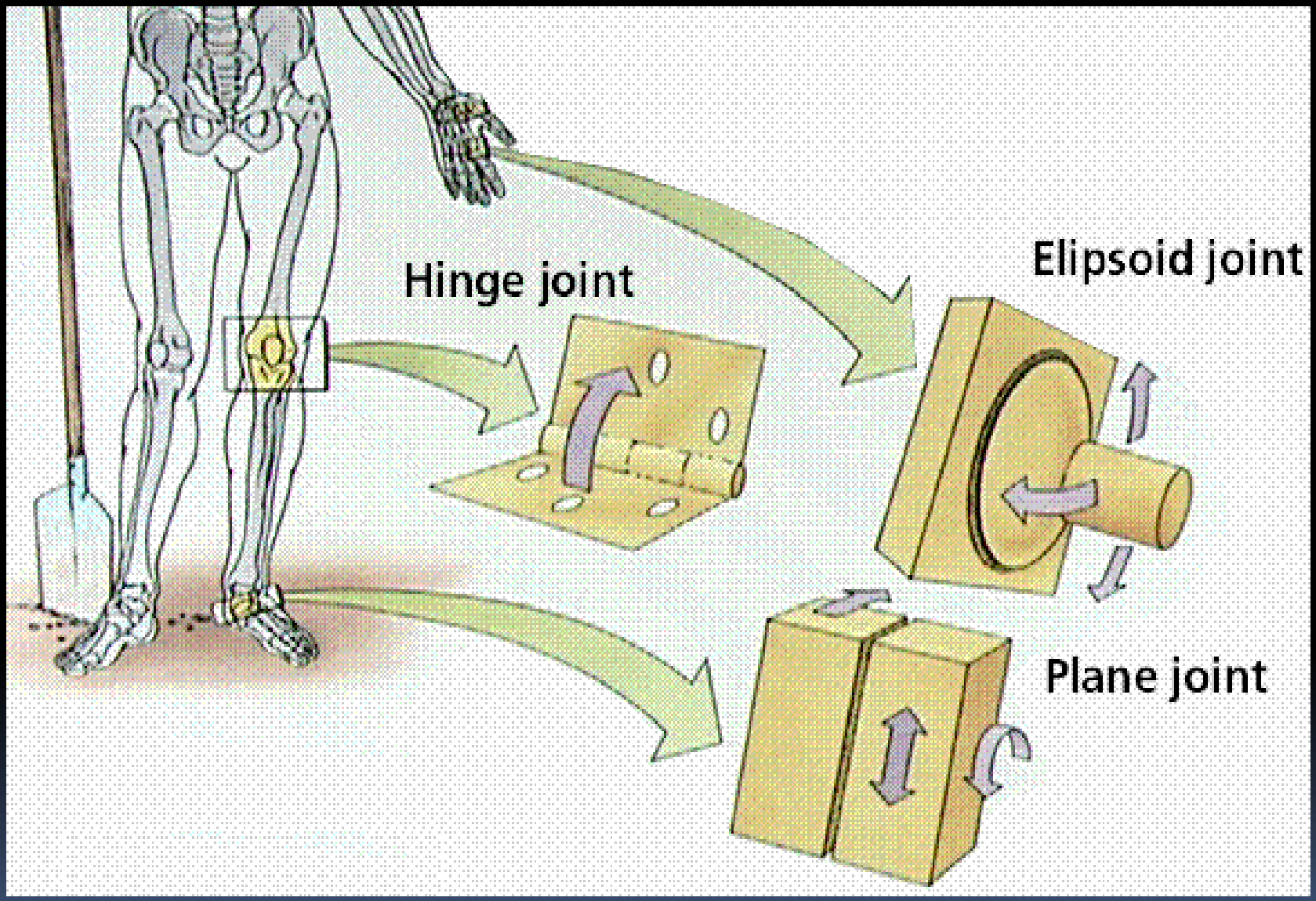

Periosteum
Ligament
Joint capsule
Fibrous capsule
Synovial membrane
Compact bone
Joint cavity (contains synovial fluid)
Articular cartilage
(A) Synovial joint
Schematic model
Femur
Synovial membrane
Meniscus
Infrapatellar fat pad
Tibia
Knee joint


bone (femur)
cartilage
meniscus
synovium
bone (tibia)
antibodies develop from autoimmune response
effects of wear and tear on aging cartilage
inflamed synovium
degenerated cartilage
Rheumatoid arthritis
Osteoarthritis

Based on the surface form of diarthrosis:

1. Articulatio plana
2. Articulatio sellaris (saddle joint, pelana)
3. Ginglymus (hinge joint, engsel)
4. Articulatio trochoidea (pivot joint, putar, pasak)
5. Articulatio condyloidea
6. Articulatio ellipsoidea
7. Artic. spheroidea (ball &socket joint,globoidea)


Types of Joints
Ball and socket joint
Pivot joint
Saddle joint


Hinge joint
Elipsoid joint
Plane joint

Gerakan –gerakan pada sendi

- Fleksi : gerakan menekuk atau mengurangi sudut antar bagian tubuh
- Ekstensi : pelurusan atau penambahan sudut
- Abduksi : gerakan menjauhi bidang tengah
- Adduksi : gerakan mendekati bidang tengah
- rotasi : gerakan mengelilingi aksis panjang

- Protrusi : gerakan kedepan
- Retrusi : gerakan ke posterior
- Pada lengan bawah

  - pronasi : gerakan telapak tangan menghadap posterior

  - supinasi : gerakan telapak tangan menghadap anterior

- Elevasi : mengangkat
- depresi : menurunkan
- kaki

  - inversi : gerakan kaki ke medial

  - eversi : gerakan kaki ke lateral

Articulatio plana

- Permukaan datar
- sliding/geser
- Artic. acromioclavicularis, artic. intercarpalia, artic. intermetacarpalia, artic. carpometacarpalia

Articulatio sellaris

- Permukaan sedel/pelana
- concavoconvex dgn convexoconcav
- Artic. carpometacarpalis I (gelang tangan & ibu jari tangan)

Ginglymus

- Bentuk engsel
- Uniaxial
- satu derajat kebebasan gerak: flexi - extensi
- Artic. humero-Ulnaris (artic. cubiti), artic. Interphalangea

Articulatio trochoidea

- Permukaan mirip roda
- Satu kebebasan gerak: rotasi dalam cincin
- Artic. radioulnaris proximalis/superior, Artic. atlantoaxialis

Articulatio condyloidea

- Permukaan condylus (satu atau dua) dengan fossa
- Satu condylus: Biaxial, 2 derajat kebebasan gerak:

  Flexi-extensi & abduksi – adduksi (circumduksi)

  Artic. humeroradialis (artic. cubiti)

Articulatio ellipsoidea

- Dataran sendi ellips
- Biaxial
- Dua derajat kebebasan gerak:
- flexi-extensi & abduksi –adduksi (circumduksi)
- Artic. metacarpophalangea, artic. Radiocarpea

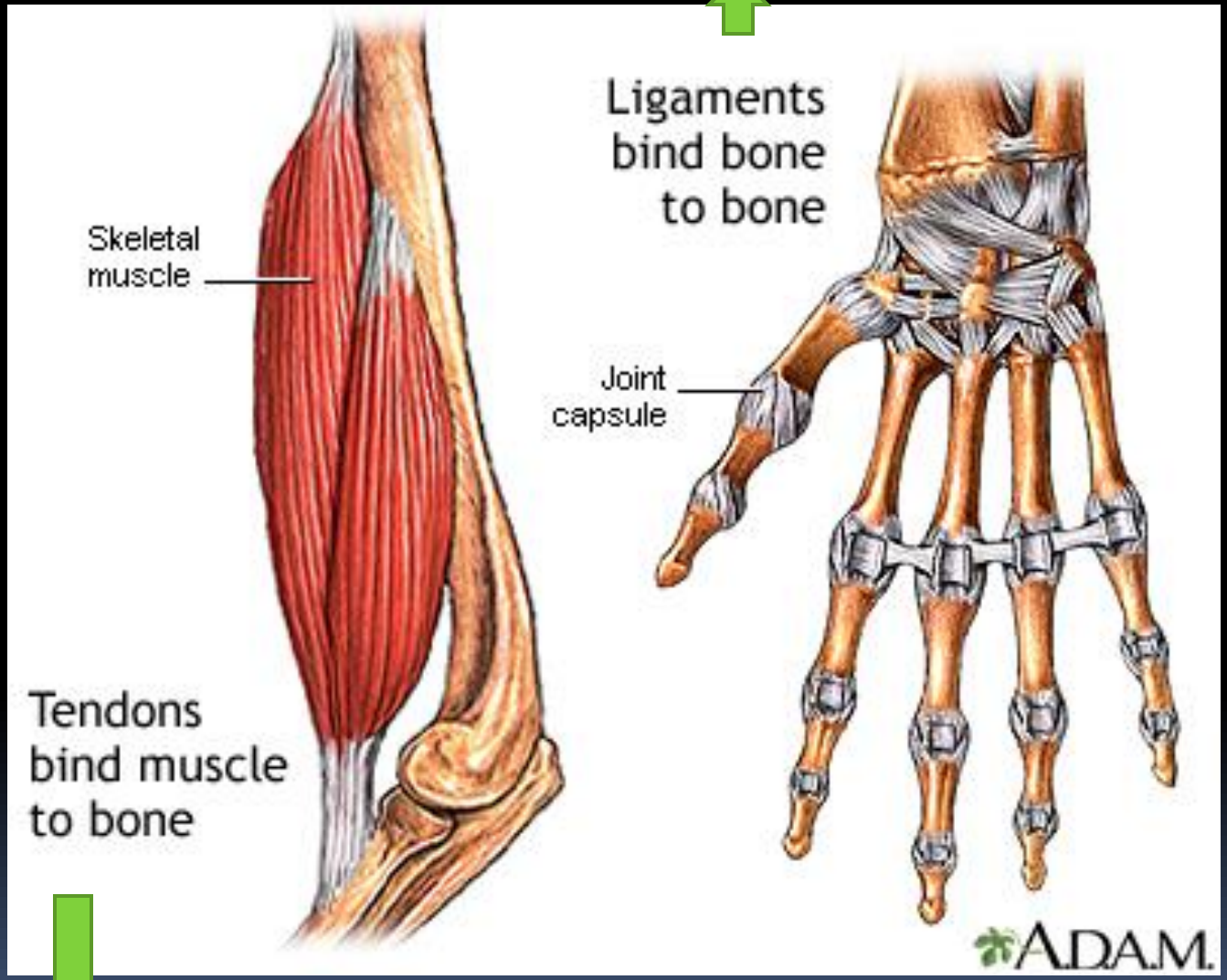
Articulatio spheroidea

- Bentuk bola & mangkok
- Multiaxial
- Flexi-extensi, abduksi – adduksi, (circumduksi), rotasi
- Artic. humeri , artic. coxae


"GEAR" FULL THROTTLE!

TENDON AND LIGAMENT

Hold structure together
Stabilize of the joint.

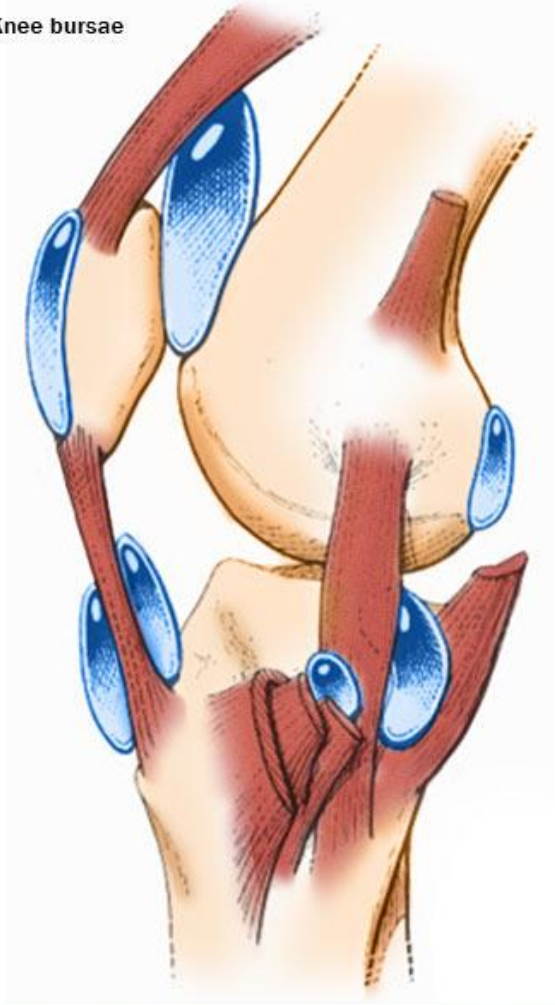


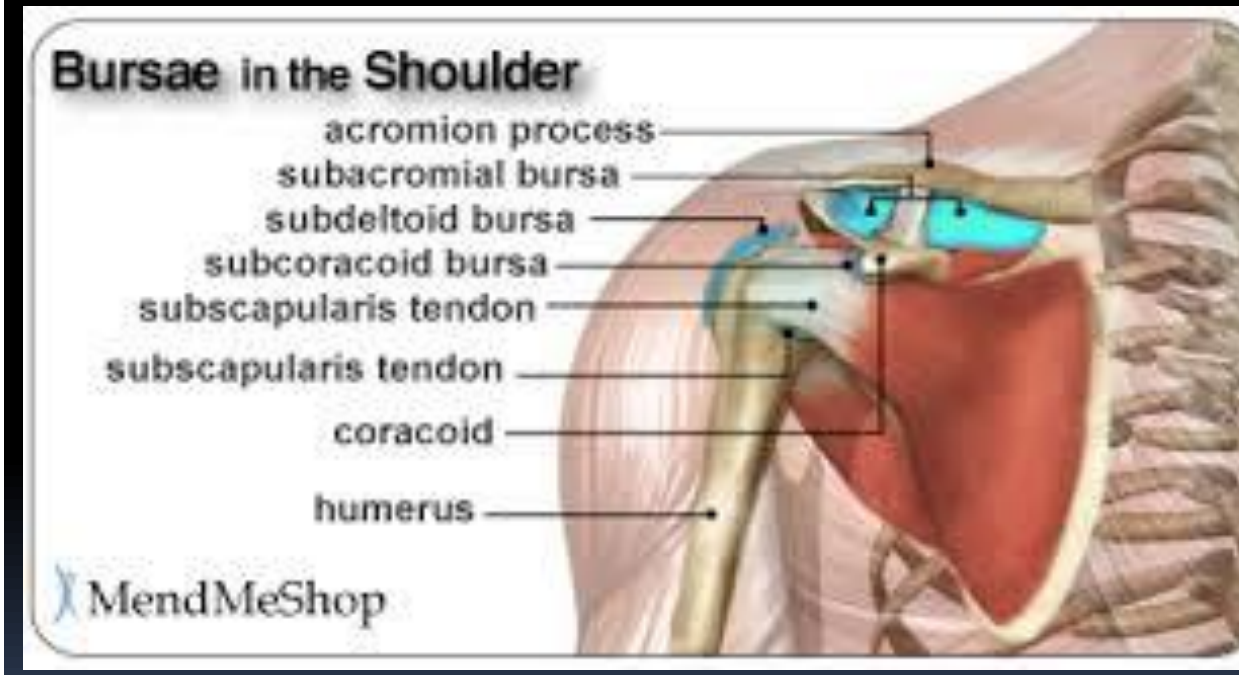
Connective tissue that attaches muscle to bone or structures

bURSAE

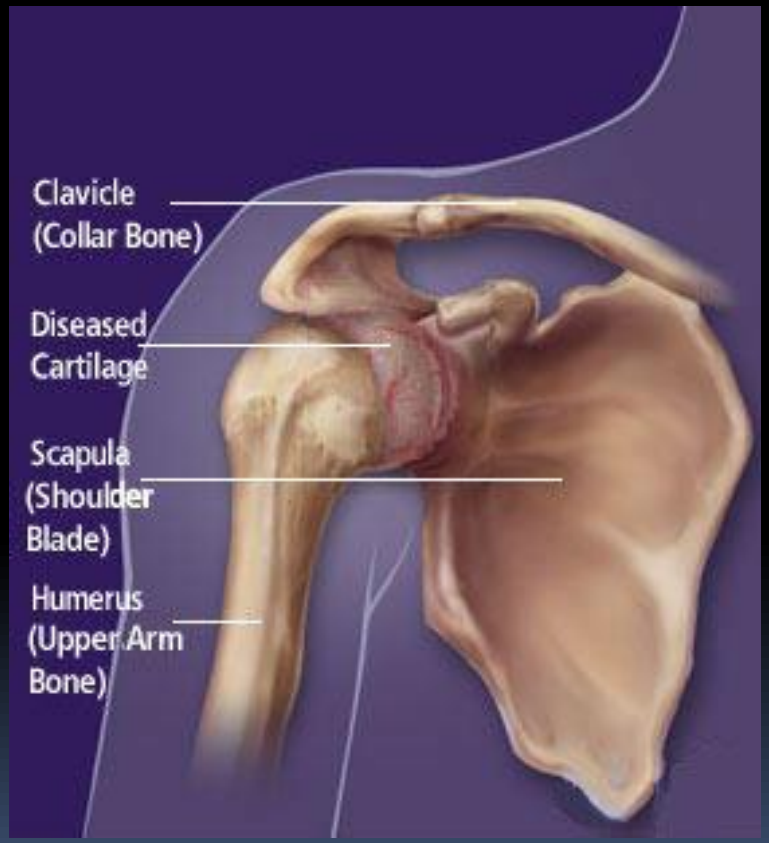
- A bursa is a fluid-filled structure that is present between the skin and tendon or tendon and bone.
- The main function of a bursa is to reduce friction between adjacent moving structures.
- Typically, bursae are located around large joints such as the shoulder, knee, hip, and elbow.

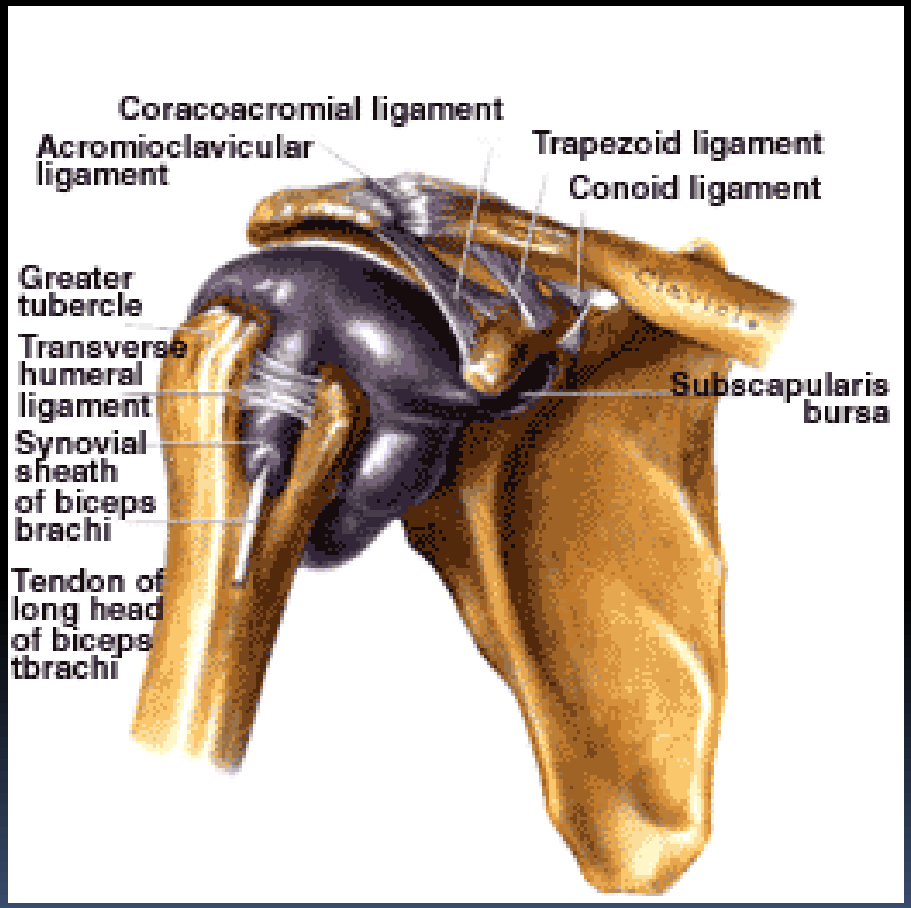
Knee bursae



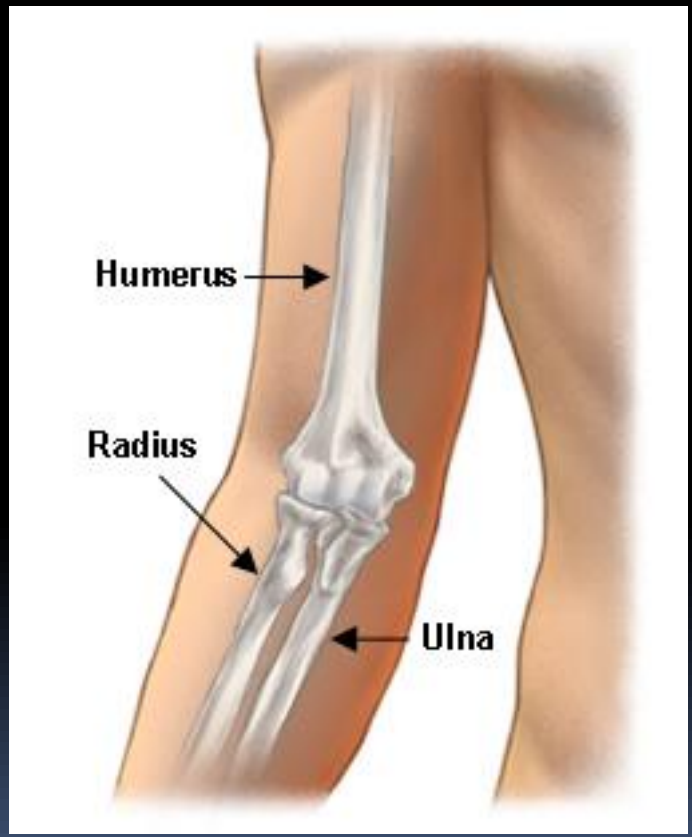


Articulatio globoidea, spheroidea

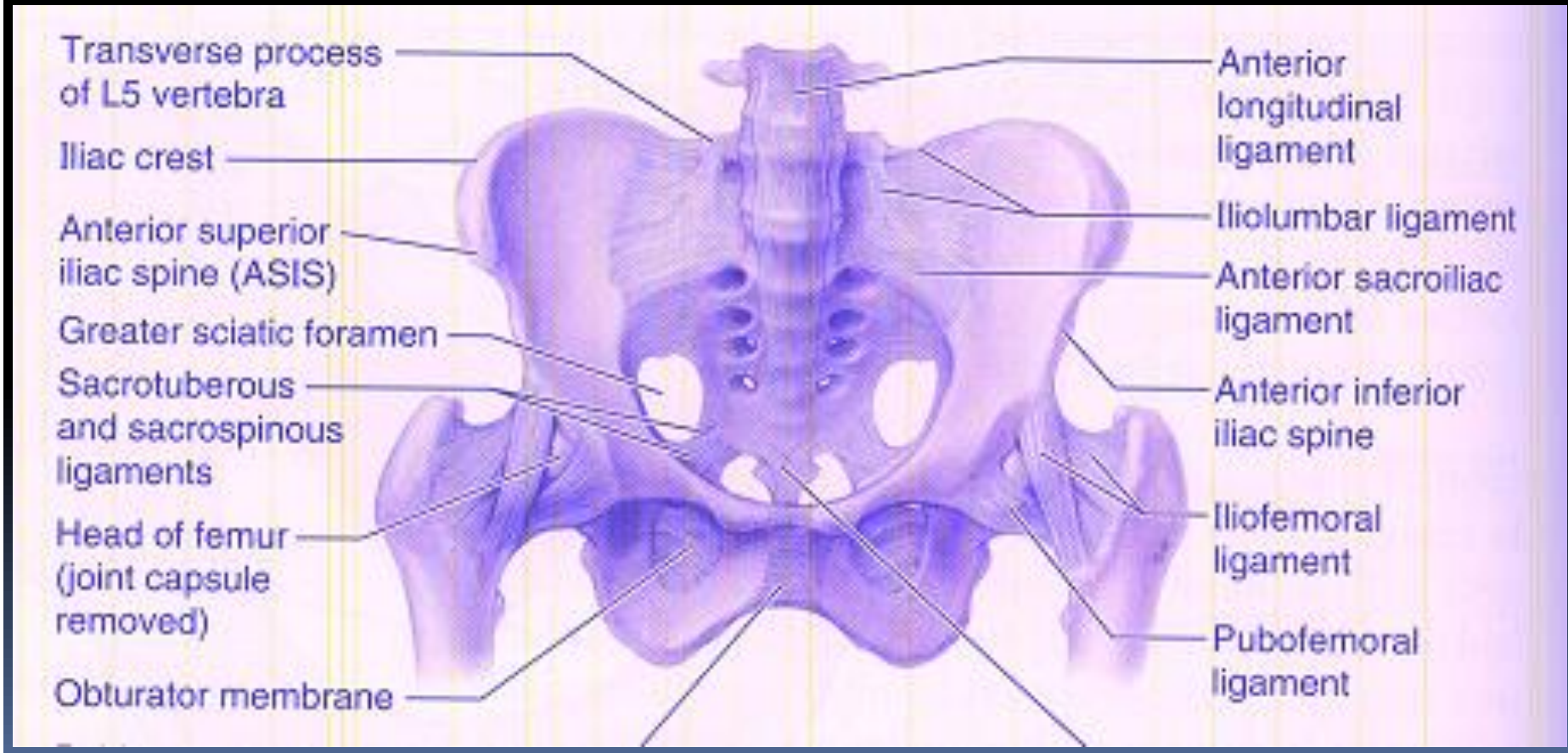




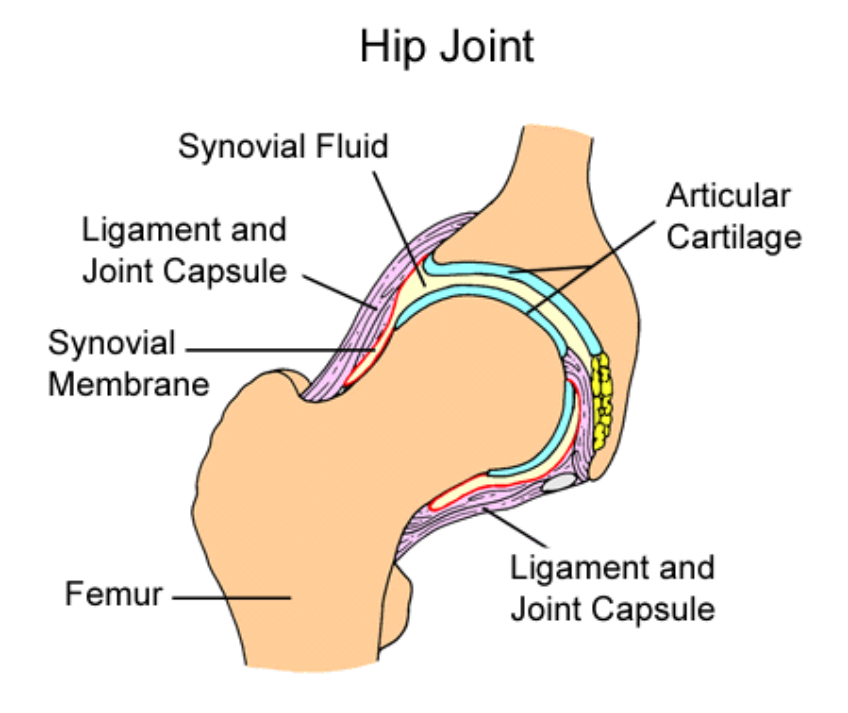
1.Articulatio cubiti: humero-ulnaris & humeroradialis
2. articulatio radioulnaris proximalis

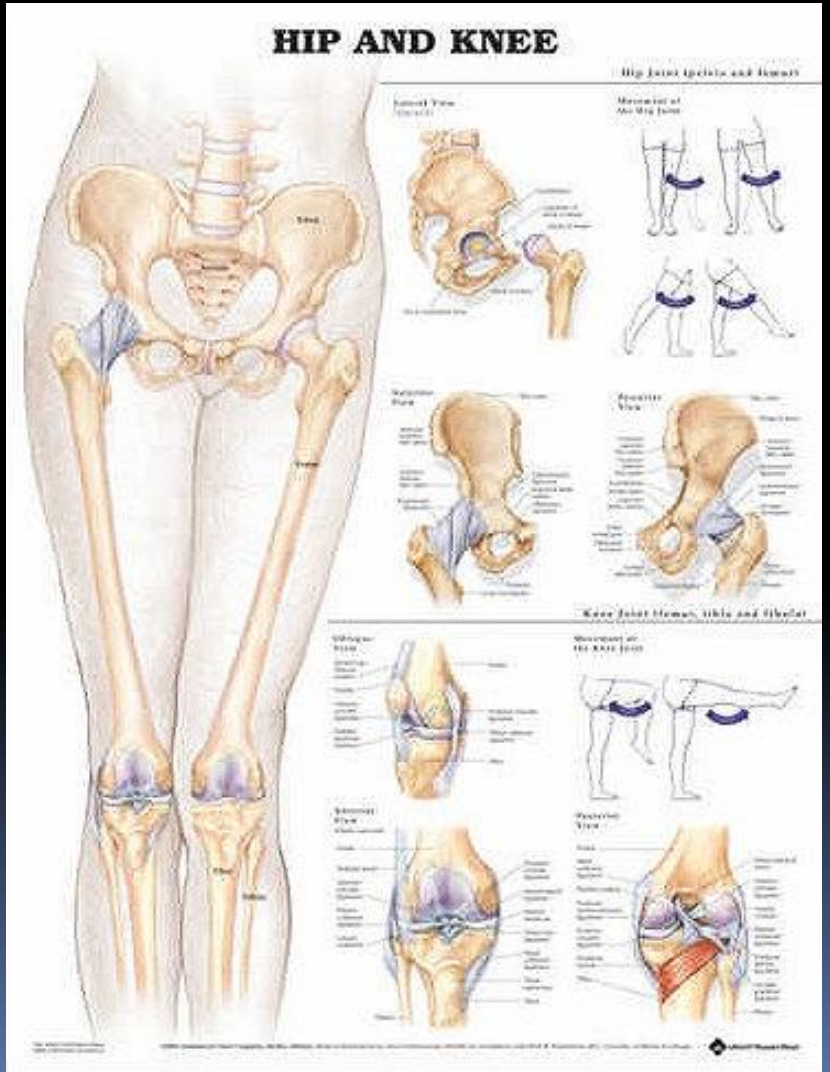


Art. Sacroiliaca

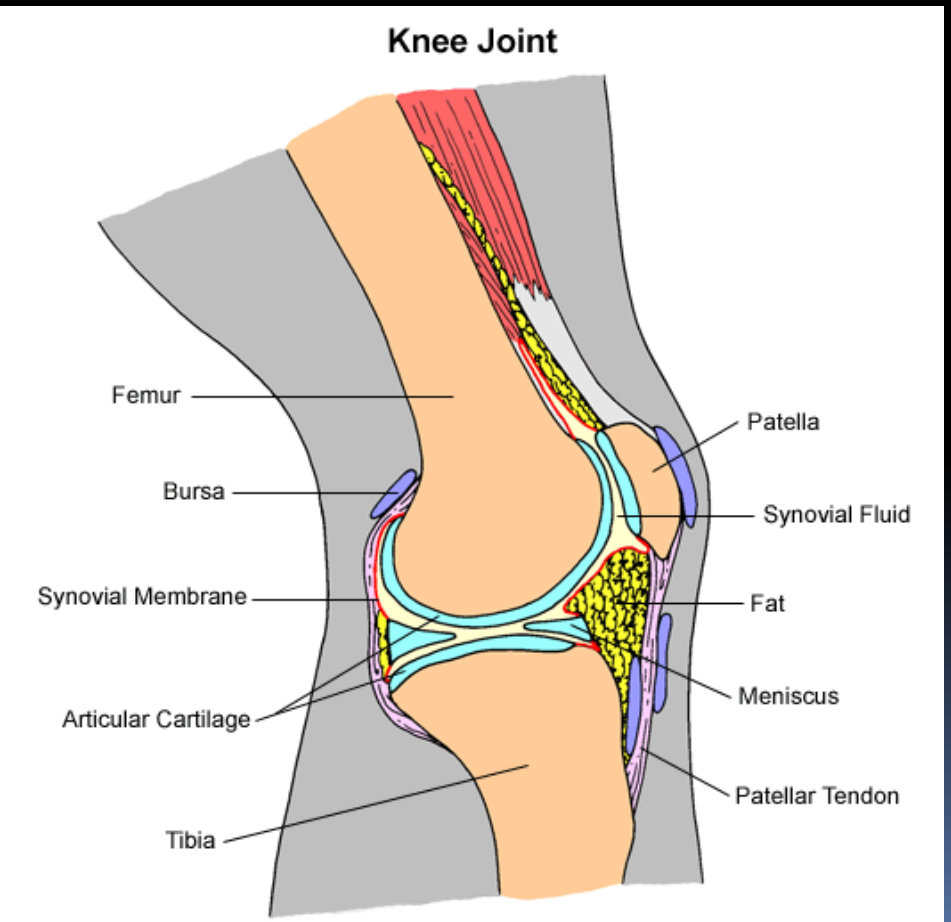


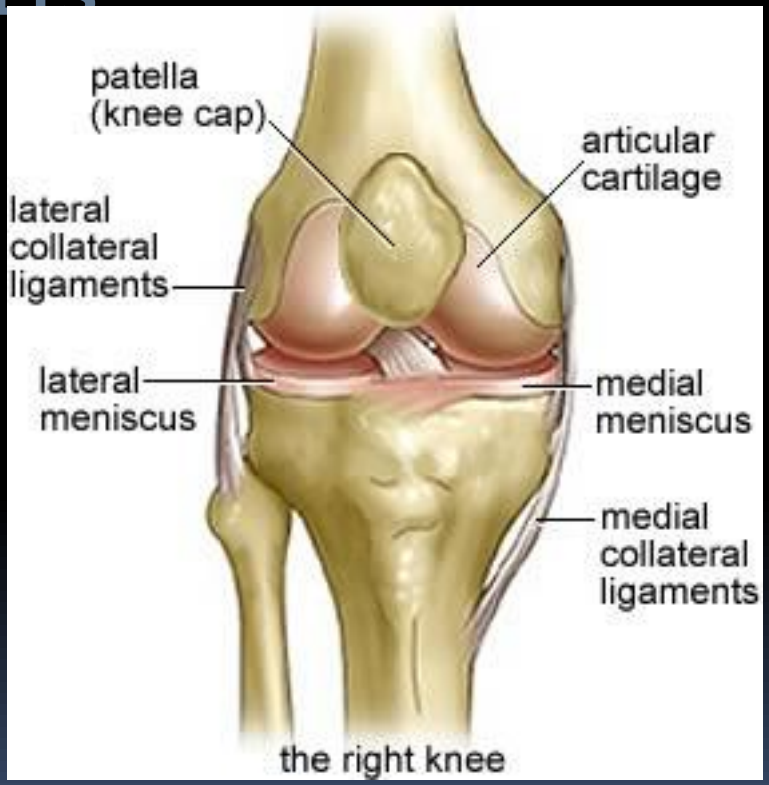
Articulatio coxae: BALL & SOCKET JOINT



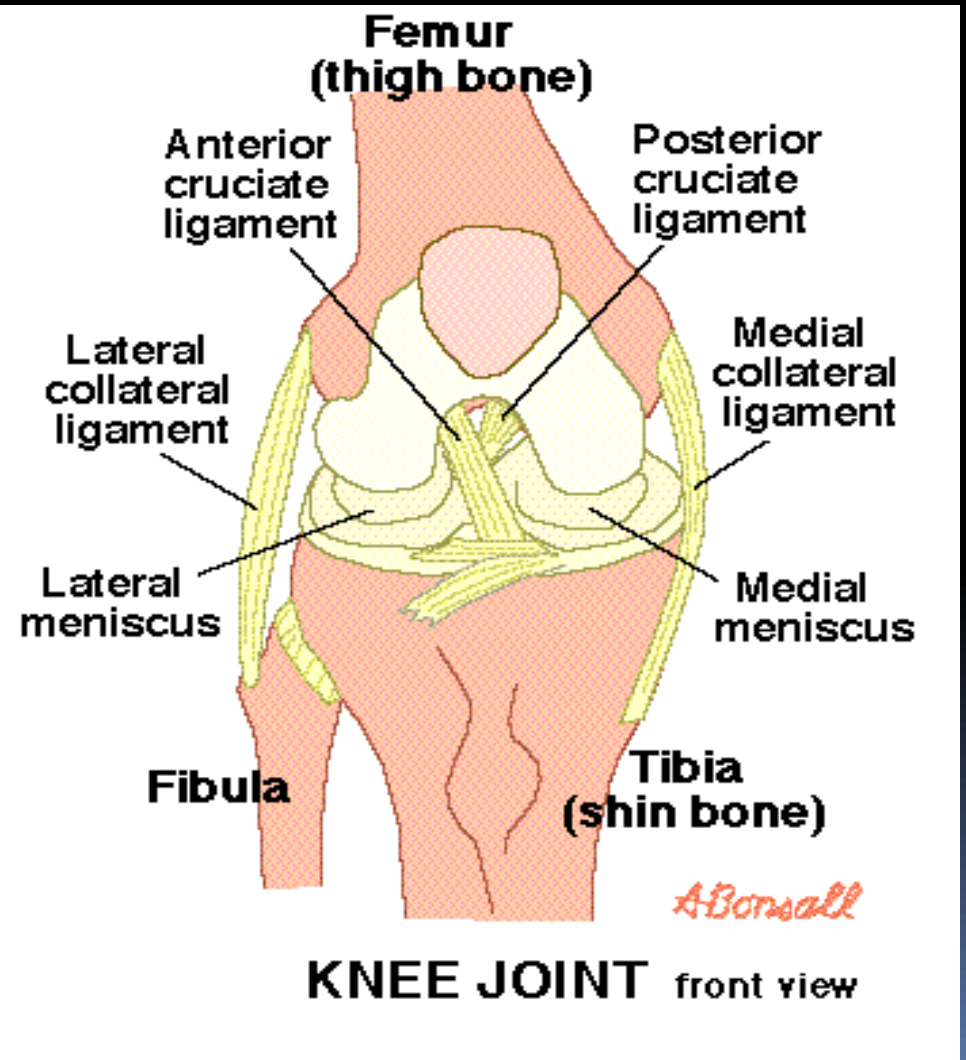


Articulatio genu : femoro-patellaris & femorotibialis articulatio tibiofibularis proximalis

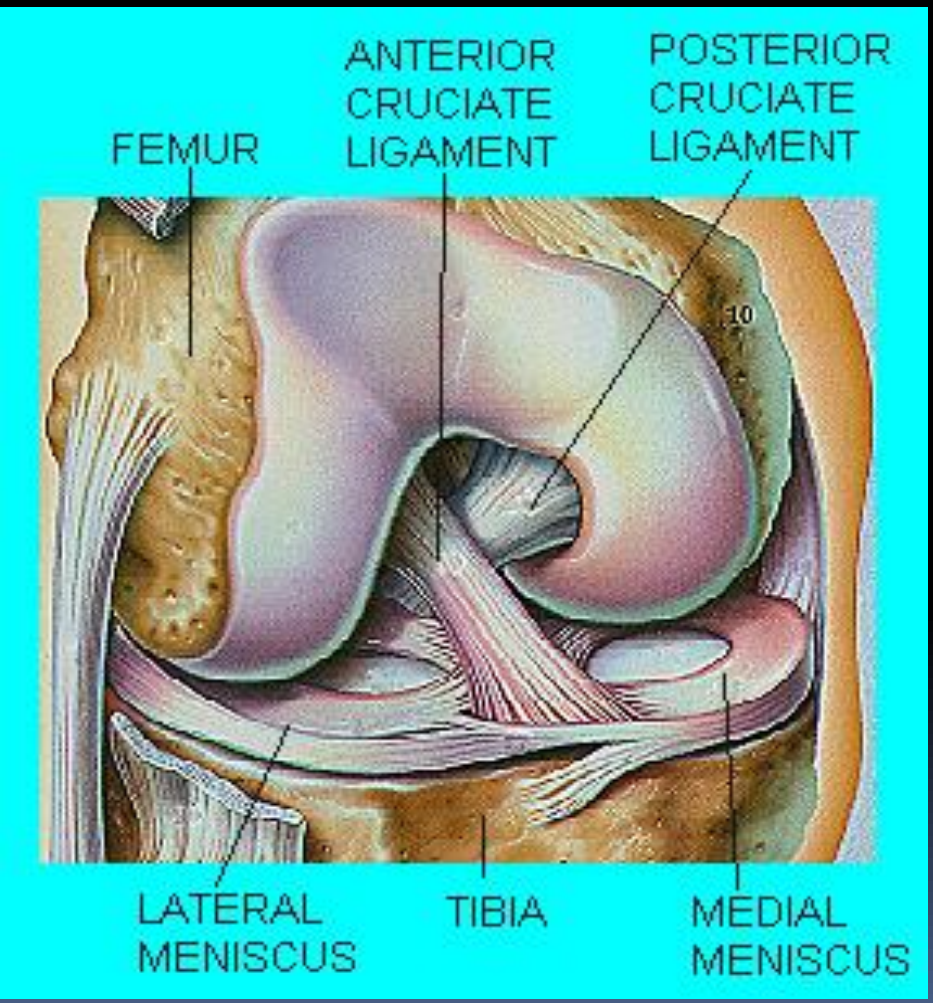




Articulatio genu, FLEKSI DAN EKSTENSI
SAAT FLEKSI – SEDIKIT ROTASI
-Ligamen dalam kapsul artikularis



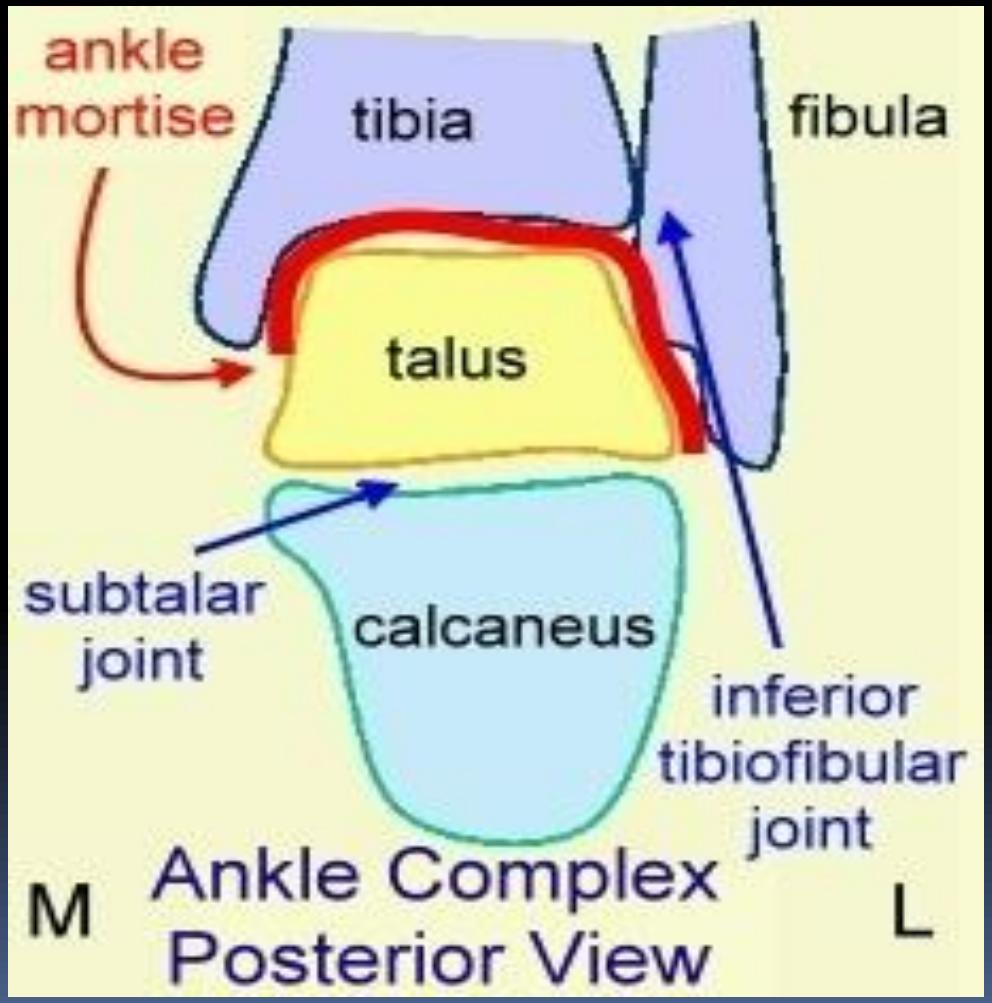
- MENISCUS MEDIALIS
- MENISCUS LATERALIS
- LIGAMENTUM CRUCIATUM ANTERIOR DAN POSTERIOR


ANTERIOR CRUCIATE LIGAMENT
POSTERIOR CRUCIATE LIGAMENT
FEMUR
LATERAL MENISCUS
TIBIA
MEDIAL MENISCUS

Articulatio talocruralis (ankle joint)
articulatio subtarsalis
articulatio metatarsophalangea
articulatio interphalangea

Ankle joint (TALOCRURALIS) & Subtalar joint

- DORSIFLEKSI DAN PLANTARFLEKSI
- Subtalar joint for Eversion & inversion



Kenapa kok sendi-sendi kehidupan?
Bukan tulang-tulang kehidupan....

Although learning is tough, struggling is a must…

One Piece, Enies Lobby arch
Luffy VS Blueno