April 12, 2017

Overview of the Skeleton, Joints & Appendicular Skeleton

The Skeleton

What do we need to know?

- Every part of the skeleton may be subject to disease or trauma
- Radiographers need to know where to aim!
- Radiographers need to be able to describe our findings and ***WHERE*** we may have demonstrated a problem
- Radiographers need to speak the same language as clinicians, nurses physiotherapists, occupational therapists etc.

Functions of the Skeleton

Bone tissue makes up 18% of the weight of the human body
Six basic functions of the skeleton:

- ***Support*** – provides structural framework to support soft tissues and provide attachment points for the tendons and most skeletal muscles
- ***Protection*** – for most of the important internal organs

- ***Movement*** – skeletal muscles attach to bones
- ***Mineral homeostasis*** – storage of calcium & phosphorus:
  contribute to bone strength, released from the bone into the blood on demand
- ***Triglyceride storage*** – adipose cells in yellow bone marrow store triglycerides – potential chemical energy reserve
- **Blood *cell production*** – haemopoiesis (formation of blood cells)
- occurs in red bone marrow in the developing bones of the foetus and in some adult bones, i.e. pelvis, ribs, sternum, vertebrae, skull, ends of the bones of the arm and thigh

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Bones of the Skeleton

How many bones make up the ADULT skeleton?

- ***206*** named bones
- Most are ***paired*** – one of each pair on the right & left side
- Infants and children – ***more*** bones (fuse later)
- Adult skeleton grouped into 2 divisions:
  i) ***axial*** skeleton
  ii) ***appendicular*** skeleton

Axial Skeleton

- ***Skull*** and ***facial*** bones – protect brain (next term)
- ***Spine***/vertebral column – protects spinal cord (next term)
- Thorax – ***rib cage*** and ***sternum*** – protects thoracic organs

Appendicular Skeleton

- The appendages – ***arms*** and ***legs***
- Plus the supporting framework for their ***attachment*** to the axial skeleton:
- Shoulder (pectoral) girdle
- Pelvic girdle

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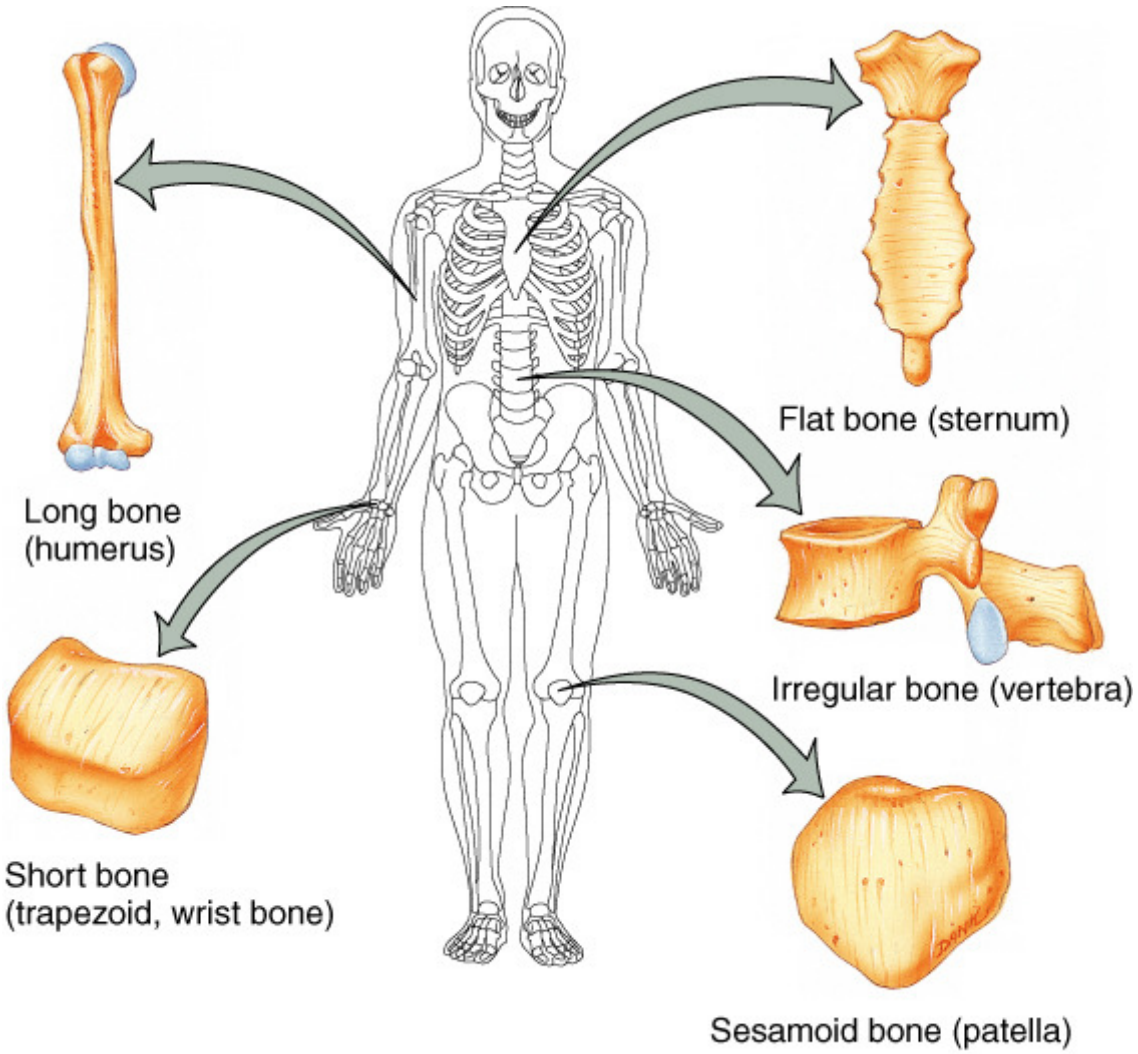
Types of Bones

All bones of the body can be classified into FIVE main categories:

- ***Long*** bones
- ***Short*** bones
- ***Flat*** bones
- ***Irregular*** bones
- ***Sesamoid*** bones
- ***Sutural*** bones



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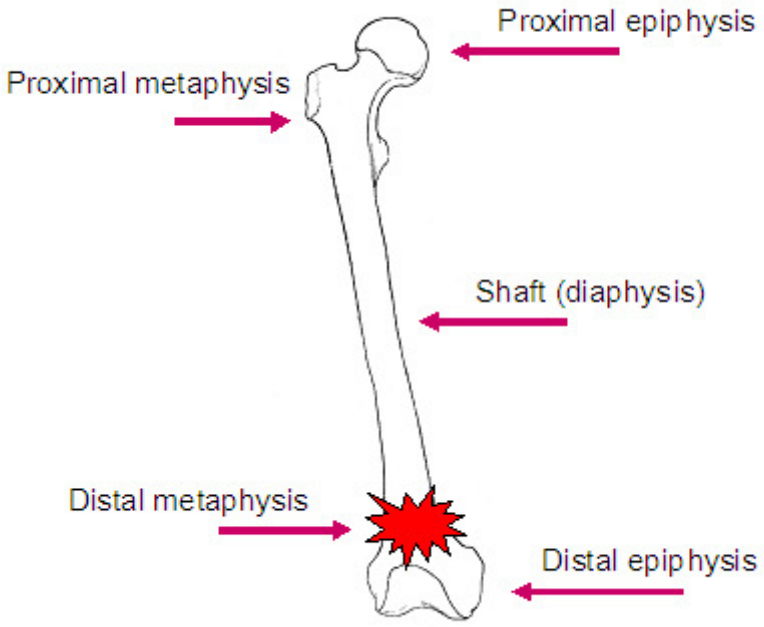
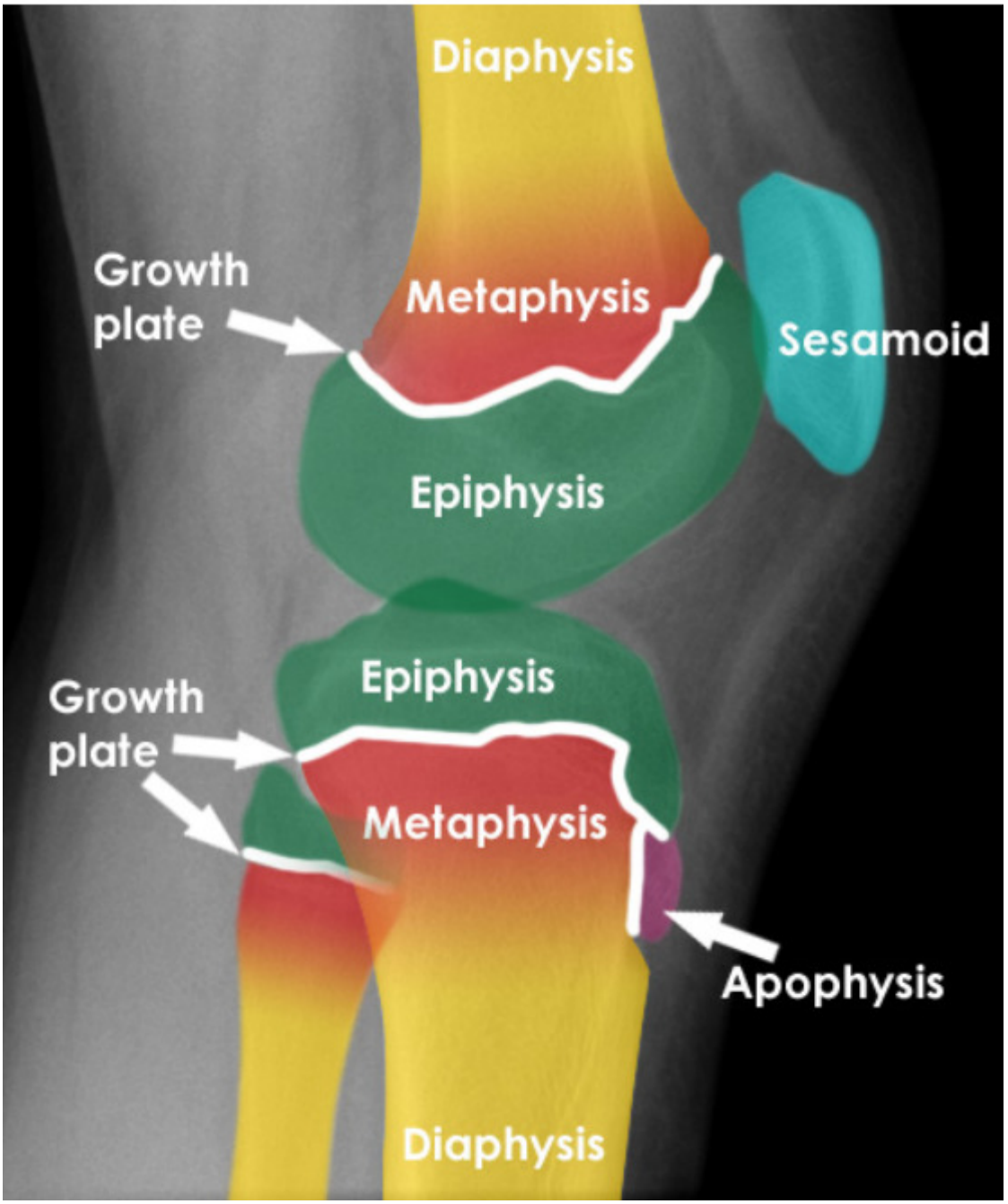
i) Long Bones

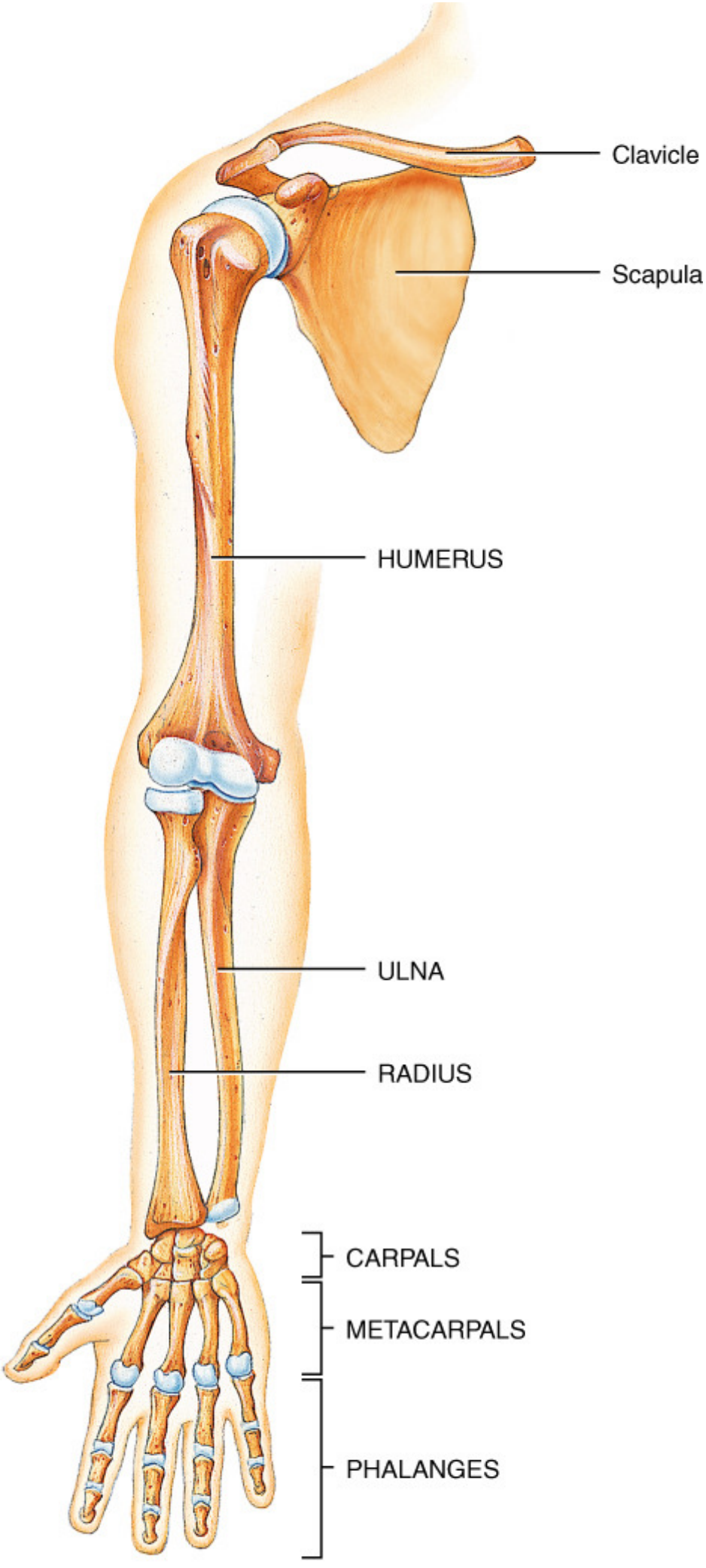
- ***Greater length*** then width
- Slightly ***curved*** for strength – straight bones would fracture easily
- ***Absorb*** the stress of the body weight
- ***Vary*** in ***size*** (femur – phalanges)
- ***Dia***physes – mostly ***compact*** bone tissue
- ***Epi***physes – ***spongy*** bone tissue


Proximal epiphysis
Proximal metaphysis
Shaft (diaphysis)
Distal metaphysis
Distal epiphysis



ii) Short Bones

- Cube-shaped – nearly ***equal*** in length and width
- Consist of ***spongy*** bone tissue except at the surface, which has a thin layer of compact bone tissue
- e.g. carpal bones (pisiform = sesamoid bone)
- tarsal bones (calcaneus = an irregular bone)


Clavicle
Scapula
HUMERUS
ULNA
RADIUS
CARPALS
METACARPALS
PHALANGES

Anterior view

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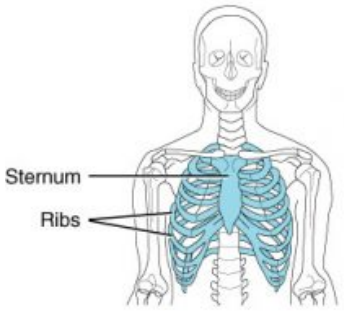
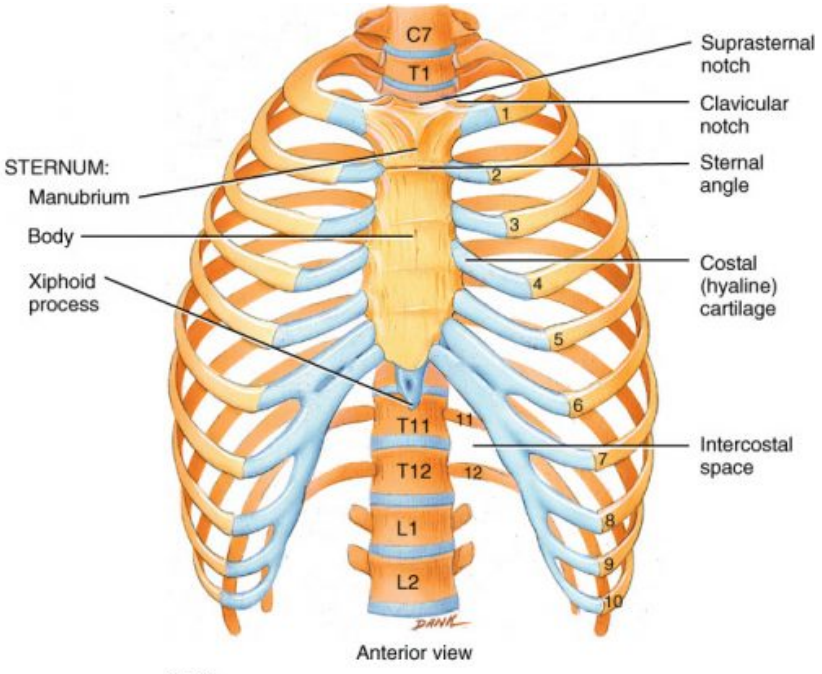
iii) Flat Bones

- Generally ***thin***
- Composed of 2 parallel plates of compact bone tissue ***enclosing*** a layer of spongy bone tissue
- Afford ***protection*** to organs
- Provide extensive areas of muscle ***attachment***
- e.g. cranial bones
- sternum
- ribs
- scapulae





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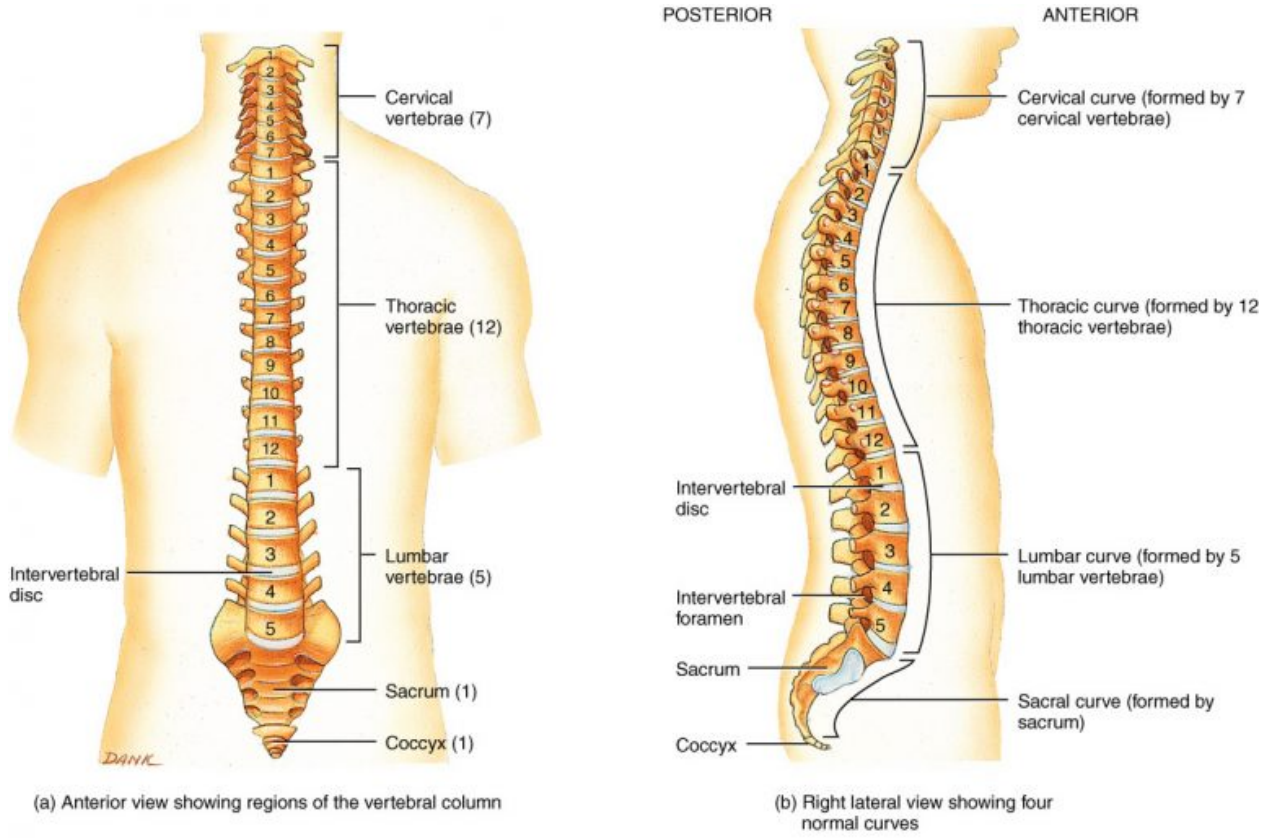
iv) Irregular Bones

- ***Complex*** shapes
- Vary in the ***amount*** of spongy and compact bone present
- e.g. vertebrae
- hip bones
- calcaneus
- certain facial bones e.g. zygomatic arches

Vertebrae



(a) Anterior view showing regions of the vertebral column

(b) Right lateral view showing four normal curves

(c) Fetal and adult curves

(d) Intervertebral disc

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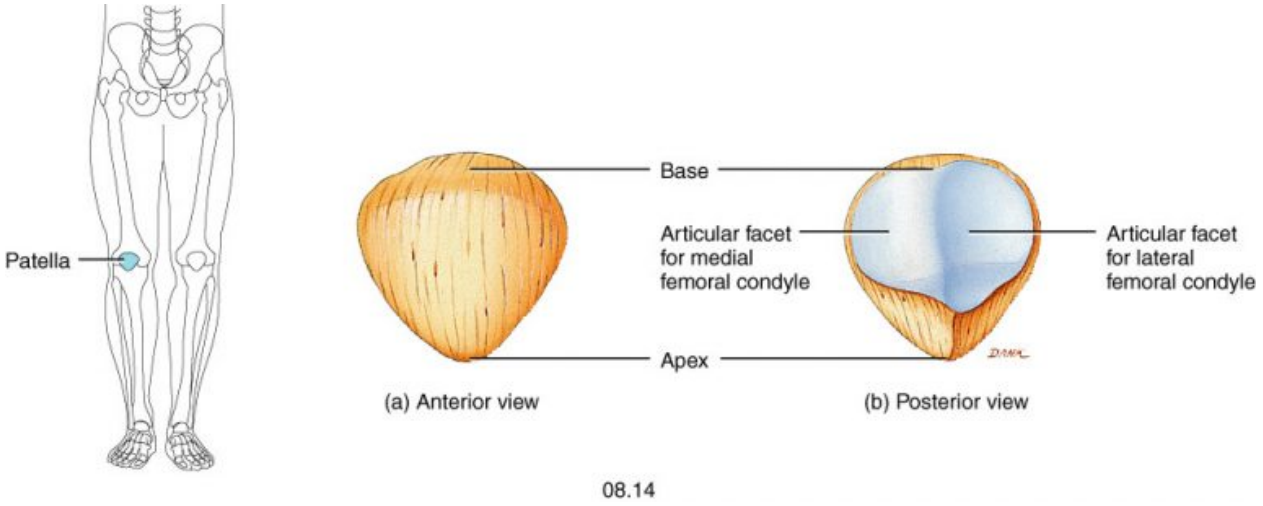
v) Sesamoid Bones

- Sesame ***seed*** shaped; not always fully ossified
- From a few mms in diameter to several cms
- ***Vary*** in number from person to person
- Develop in certain ***tendons*** where there is a considerable ***friction***,tension and physical stress

- Functionally, ***protect*** tendons from excessive wear and tear, change the direction of pull of a tendon
- e.g. adjacent to the 1st toe adjacent to the thumb
- patella – largest sesamoid bone


L
R



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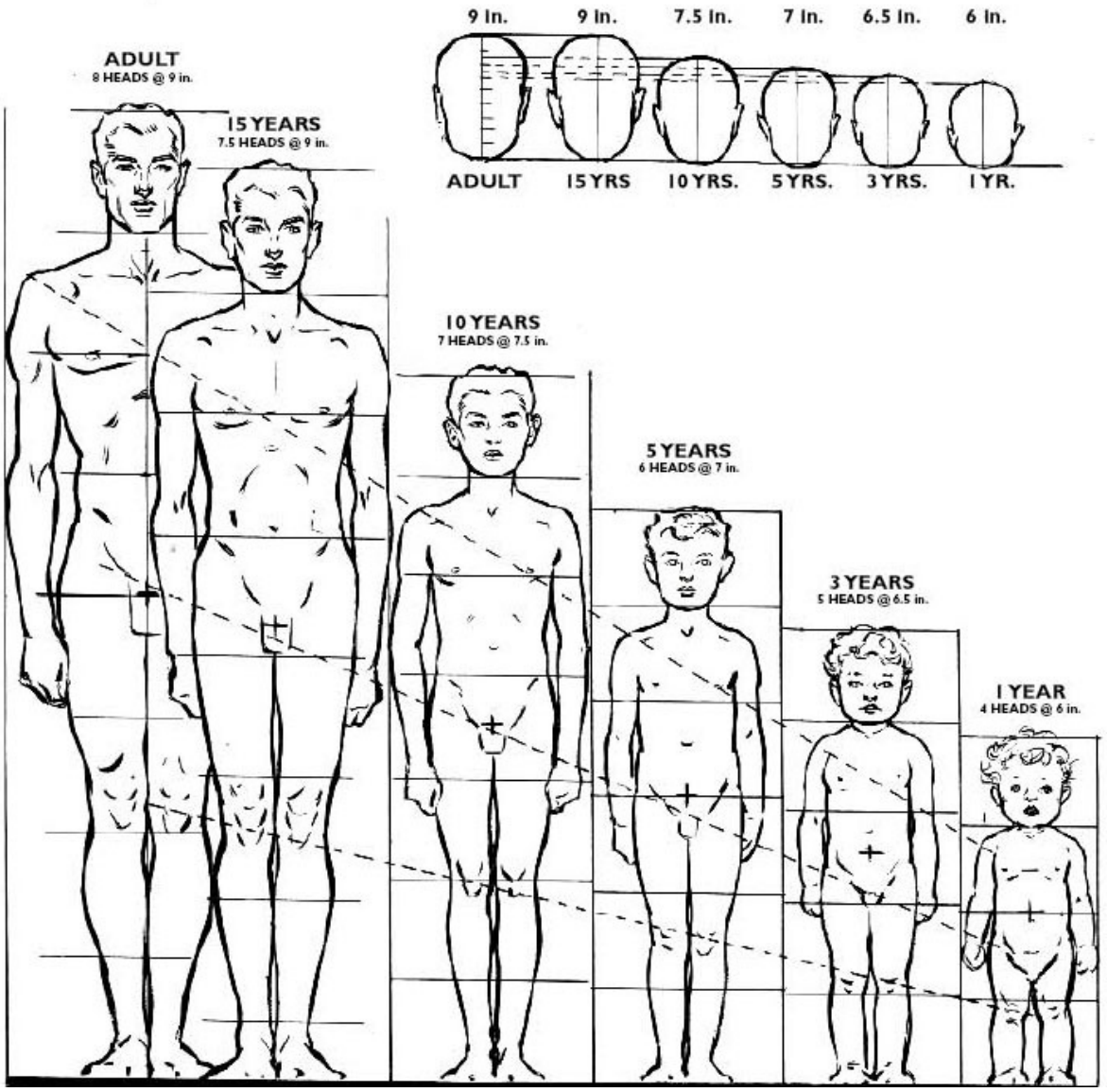
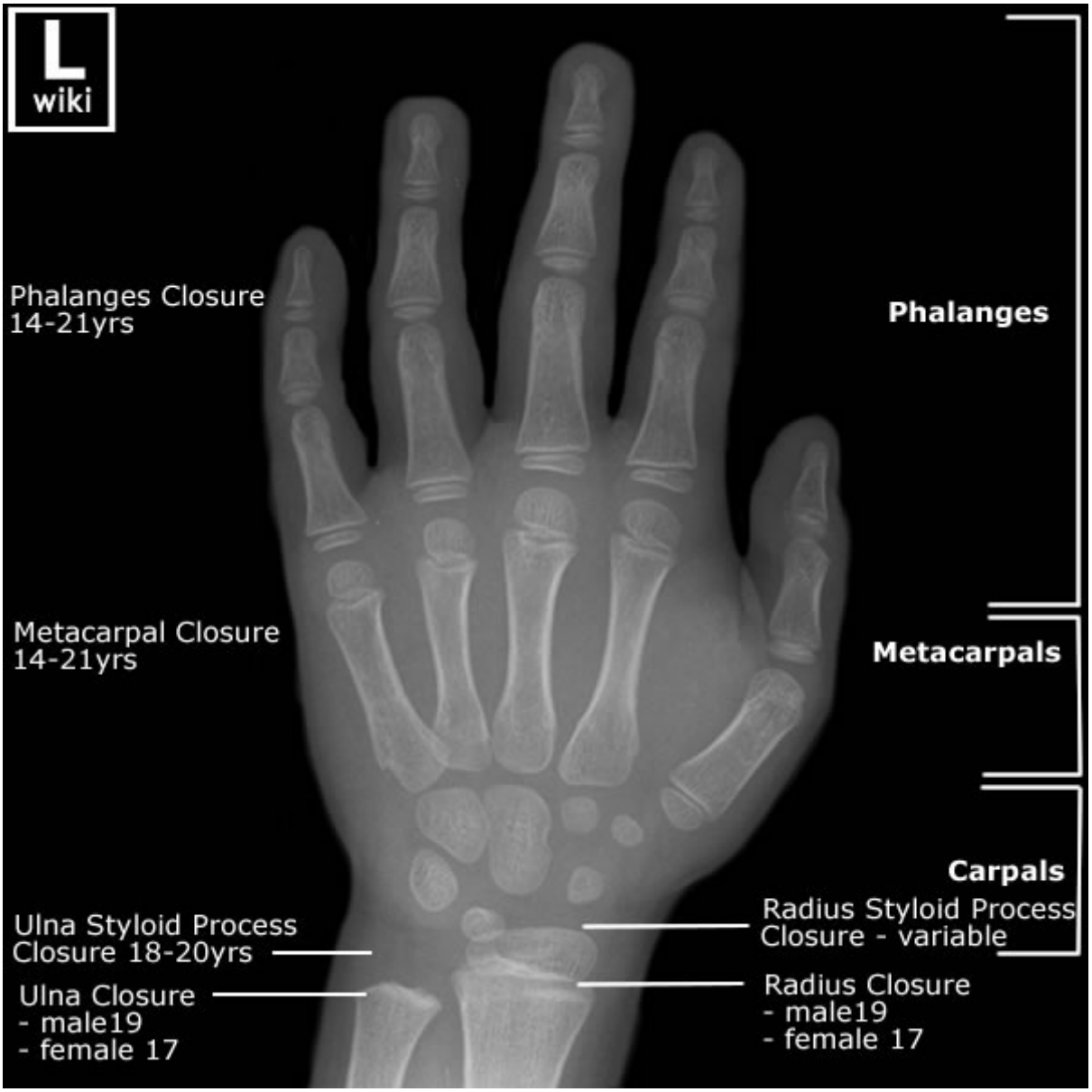
IDEAL PROPORTION AT VARIOUS AGES



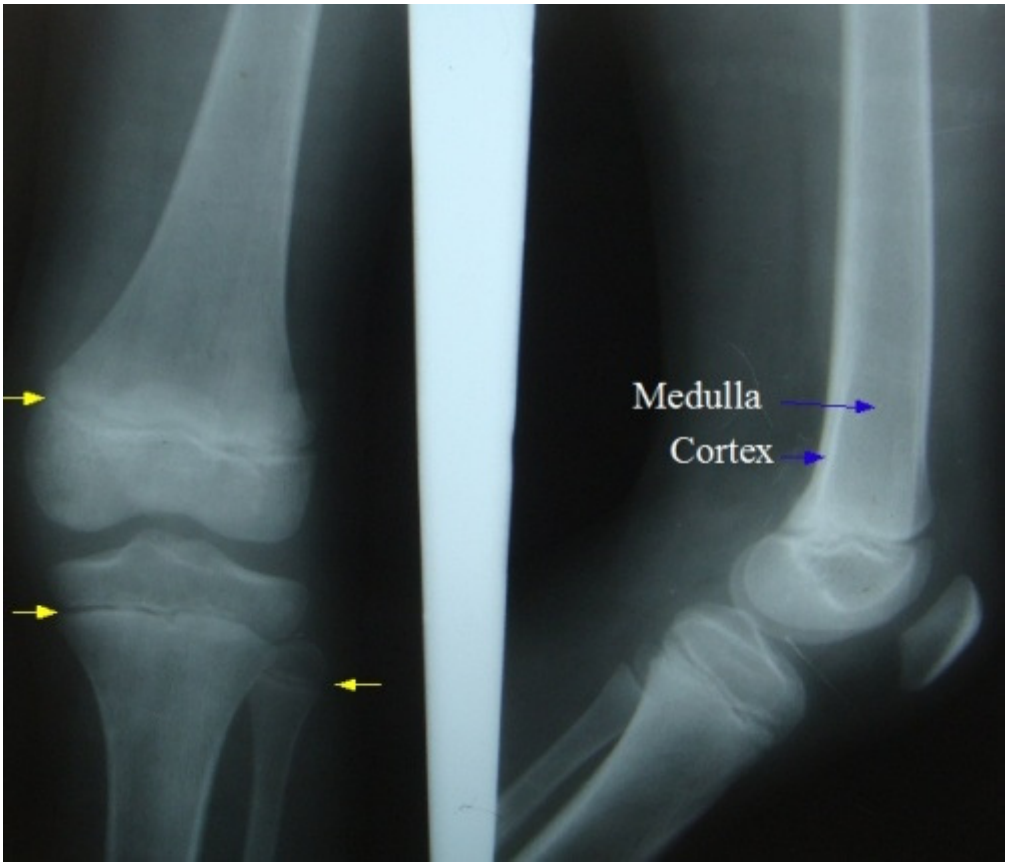
- Obvious ***size*** differences
- Head ***larger*** in proportion to body

- Bone ***formation***: some bones not present at birth, or undeveloped

- Bony development ***staged*** according to age and health



- Epiphyseal plates ***critical*** to bone age



Male vs Female Skeleton

Bear in mind:

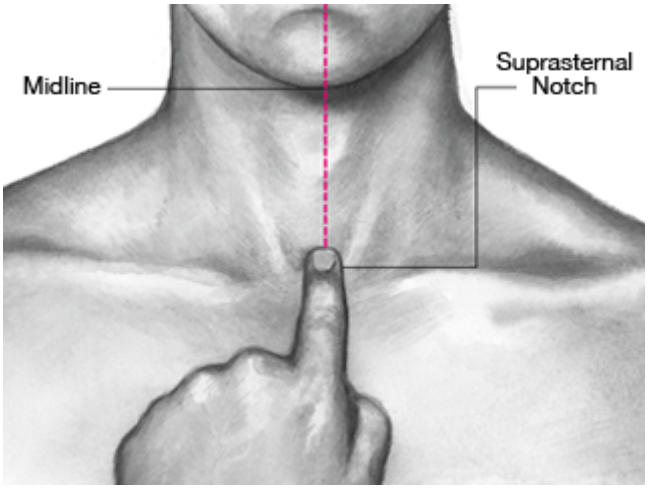
- ***Similar*** through childhood
- Adolescence – skeletal ***changes*** occur
- Female pelvis becomes wider
- Male thorax becomes wider and longer

Bone Surface Markings

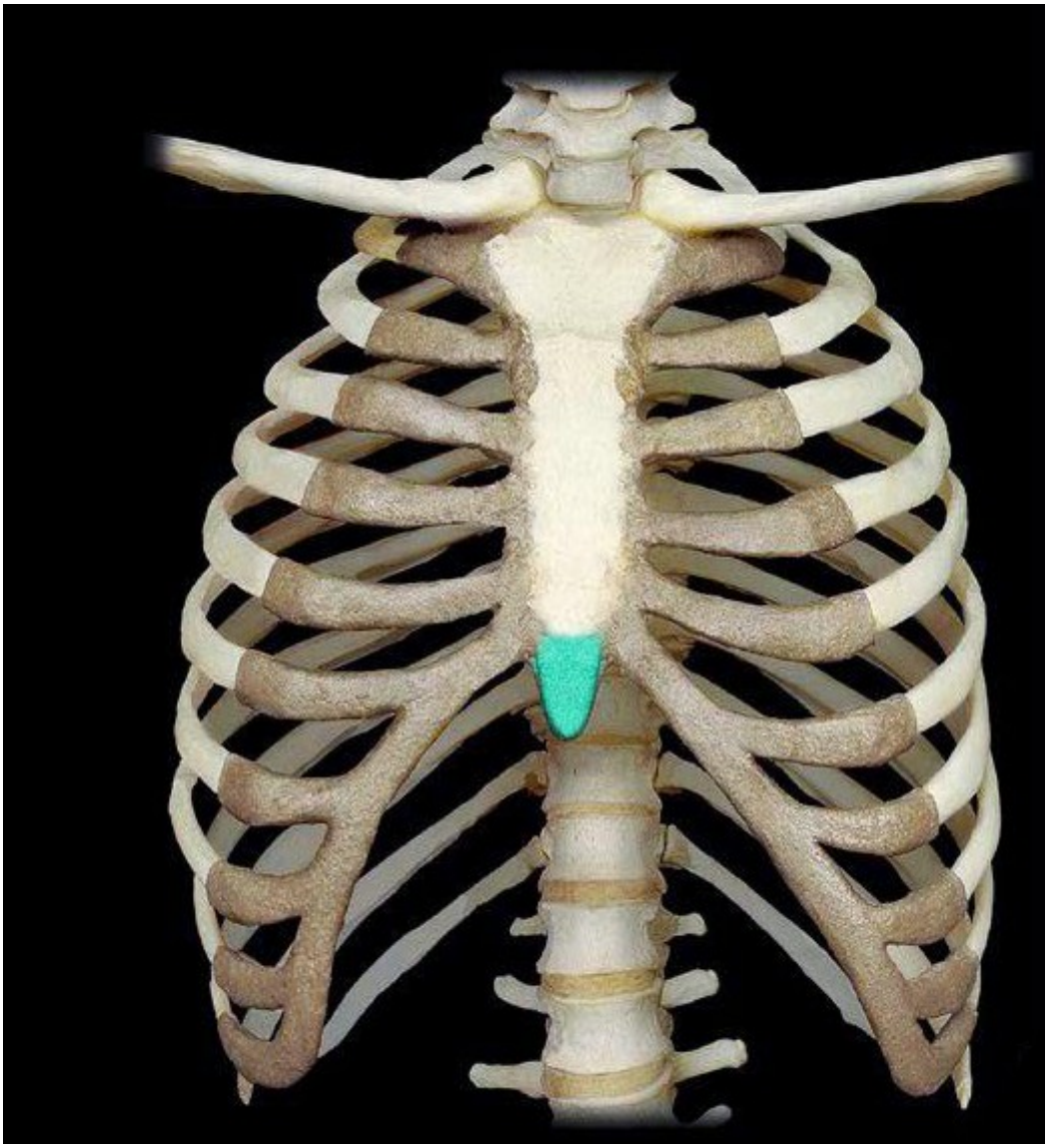
- Radiographers need to be able to find the ***bones*** we want to radiograph
- We need to use ***landmarks*** on the surface of the patient to find where we need to aim the X-ray beam

Find your….

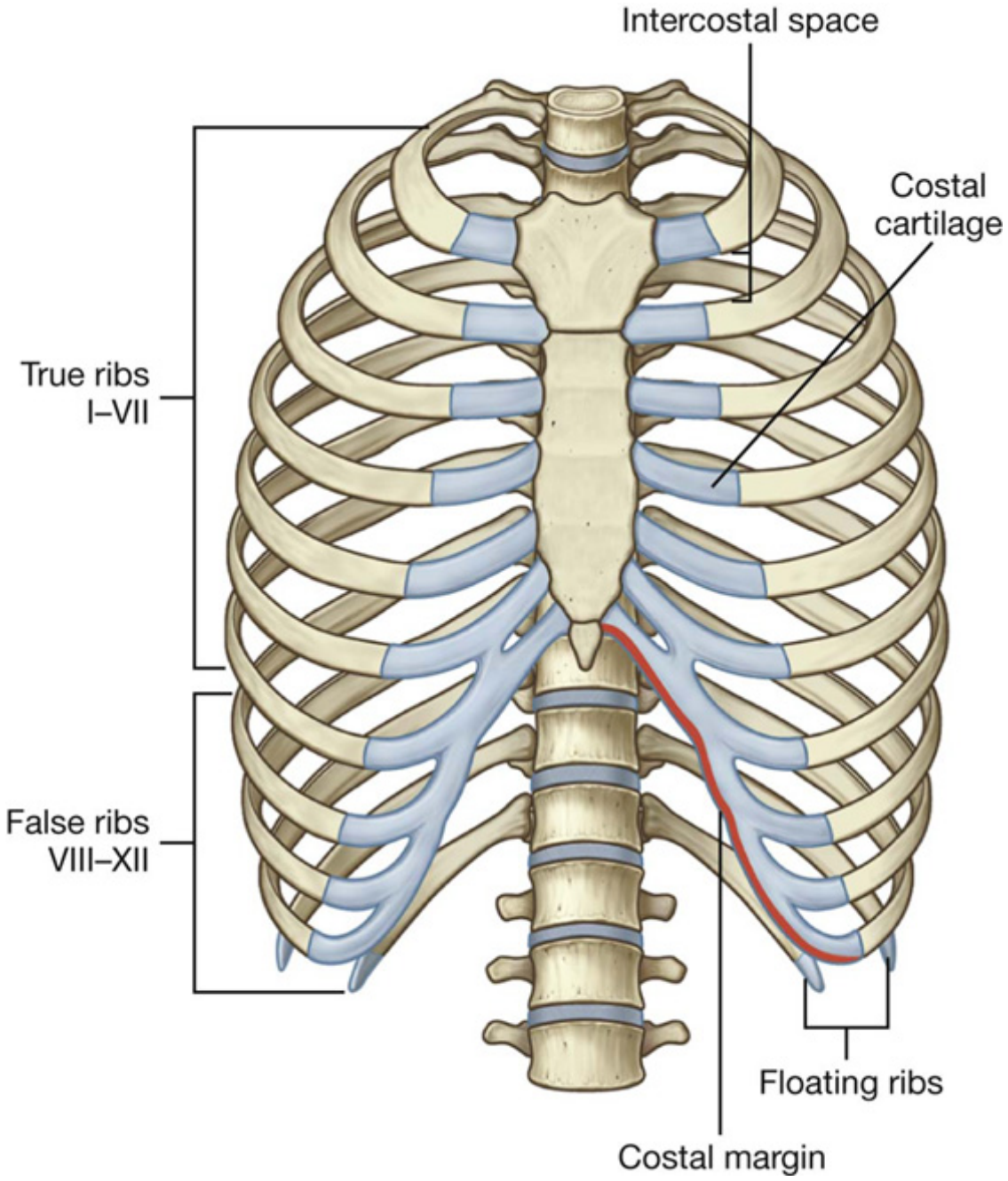
- suprasternal notch



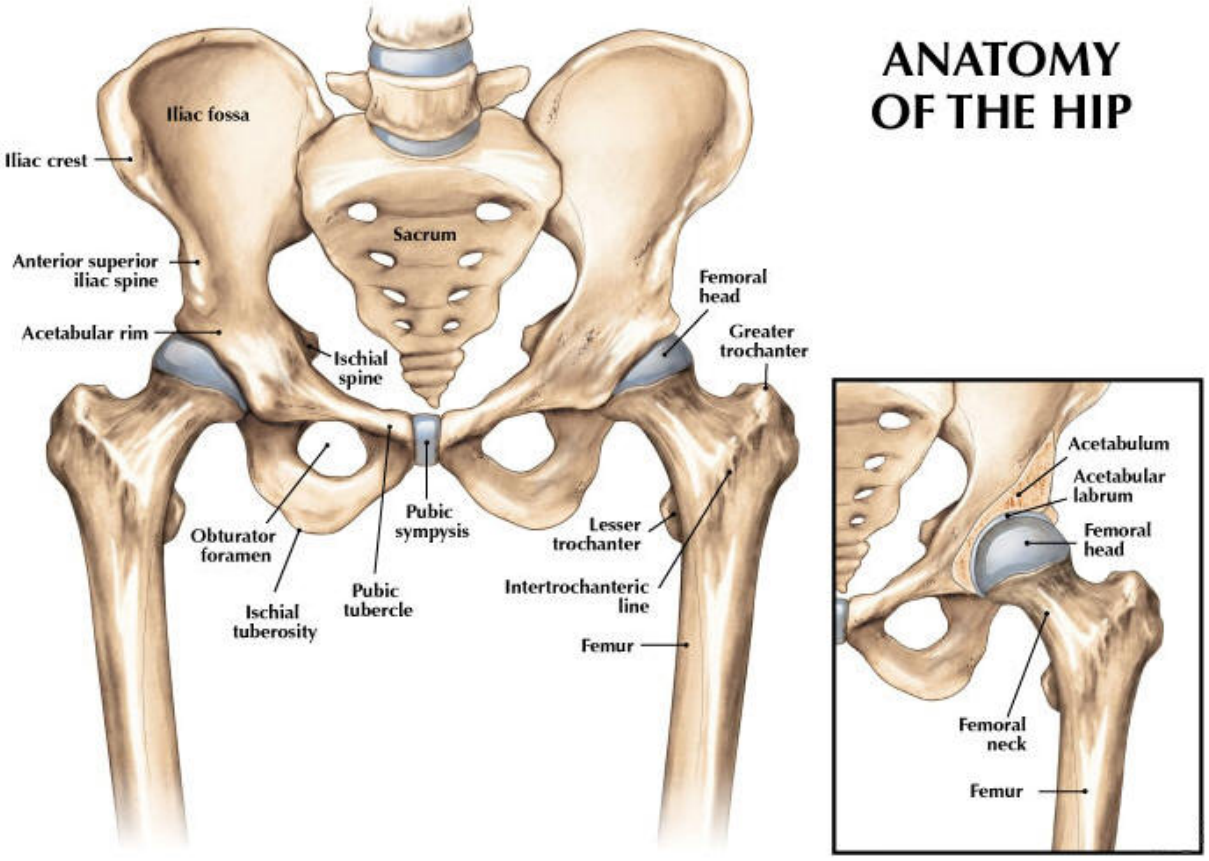
- Xiphisternum (xiphoid process)



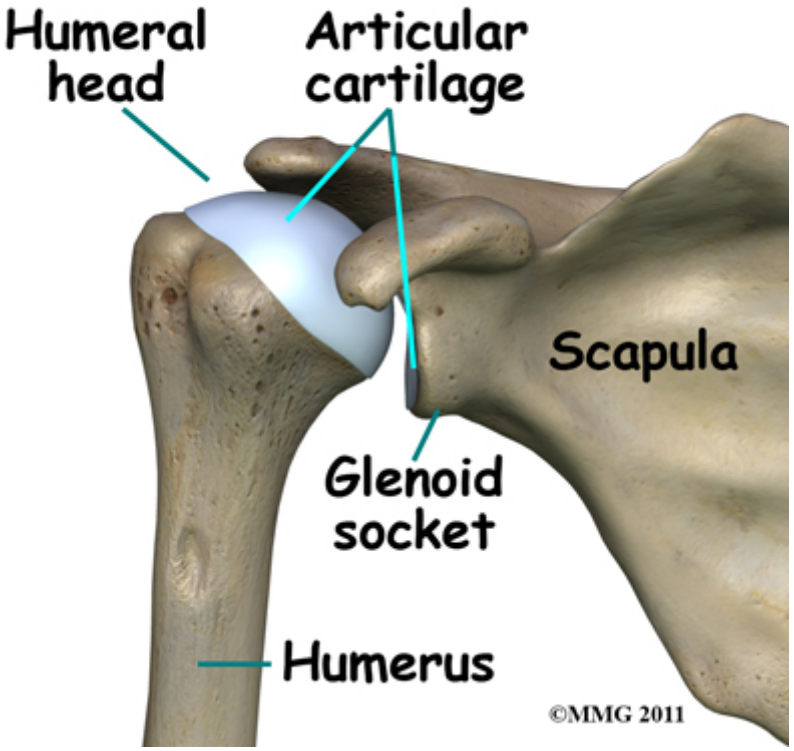
- Lower costal margin



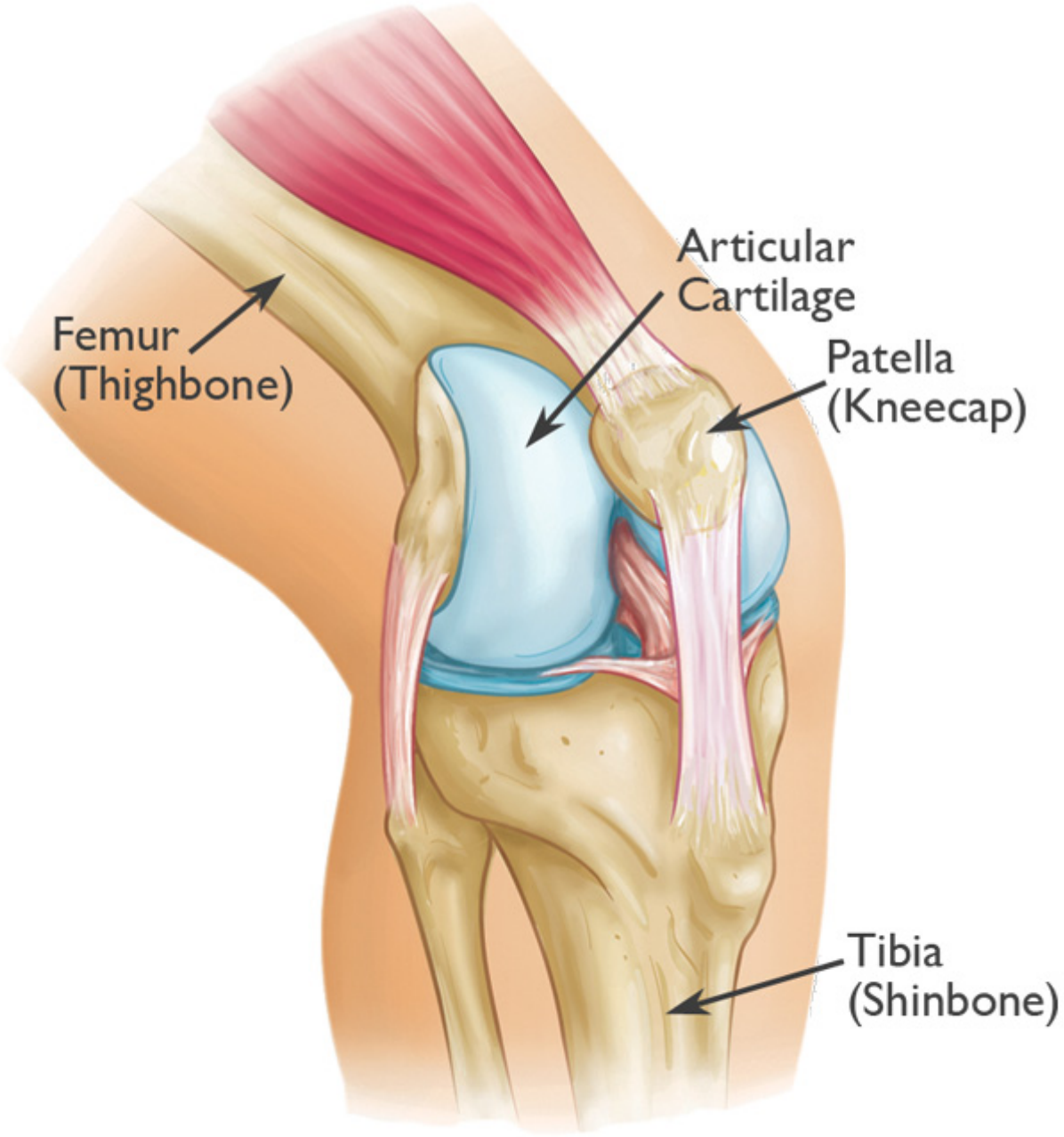
- Symphysis pubis/greater trochanter of femur



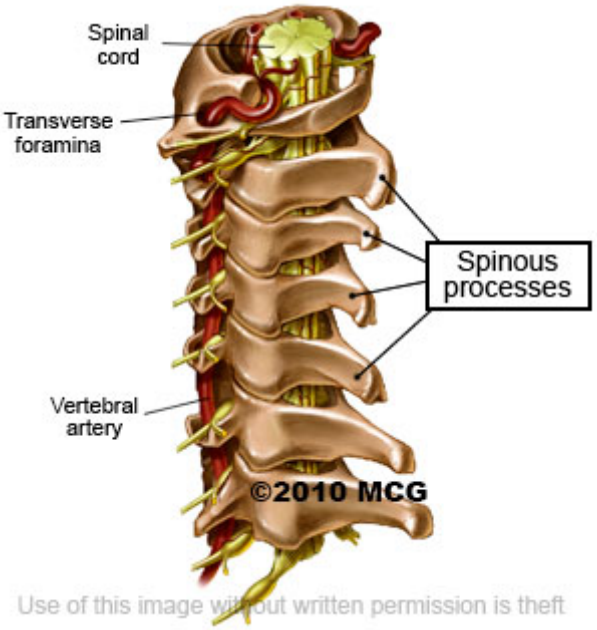
- Head of humerus


Humeral head
Articular cartilage
Scapula
Glenoid socket
Humerus
©MMG 2011

- Patella



- Spinous processes



Variations – beware

- Additional vertebrae
- Additional digits
- Scoliosis
- Childhood variations – epiphyses
- Fabella

- Terminology is important
- You need to learn the names of all bones; their features, markings and prominences

The Joints

What do we need to know?

- Joints are critical to our ***movement*** and ***mobility***
- As Radiographers we need to know how ***injury*** or ***disease*** may affect joints
- We need some understanding of their ***structure*** and their ***function***, plus bony ***anatomy*** and associated soft ***tissues*** –so that we can make sense of what is demonstrated on X-ray images

- A joint is also called an ***articulation*** or arthrosis

Is a ***point of contact*** e.g.

- between two ***bones***
- or between ***bone*** and ***cartilage***
- or between ***bone*** and ***teeth***

Functional Classification

Related to the ***degree of movement*** they permit

3 types:

- ***Syn***arthrosis – ***immovable*** – tough ***fibrous connective*** tissue
- ***Amphi***arthrosis – ***Slight*** movement – ***cartilage***
- ***Di***arthrosis – Free to move – ***Cavity***

Synarthrosis: (Greek: 'syn-' with, together)

- fixed, ***immovable*** joint
- ***articular*** surfaces are joined by tough ***fibrous*** tissue
- the edges may be ***dovetailed*** together such as the sutures of the skull

Amphiarthrosis: (Greek: 'amphi-' on both sides or around)

- ***slightly*** movable

- a pad of ***cartilage*** lies between the ***bone*** surfaces
- a ***fibrous*** capsule holds ***bone*** and ***cartilage*** in place
- cartilages in these joints = "***shock absorbers***"
  e.g. between bodies of the vertebrae

Diarthrosis: (Greek: 'dia-' through, across)

- ***freely*** moving joint
- some movement is ***restricted*** by the ***shape*** of the articulating surfaces and by the ***ligaments*** holding them together
- ligaments = ***elastic*** connective tissue
- ***synovial*** joints

Structural Classification

Structure based on ***anatomical characteristics***:

- ***Fibrous*** joints: the type of tissue binding them together is fibrous
- ***Cartilaginous*** joints: piece of cartilage between the bones; holds the bones together and makes a joint
- ***Synovial*** joints: incorporate a ***space*** between the articulating bones, called a synovial ***cavity***

Structural Classification: ***Fibrous Joints***

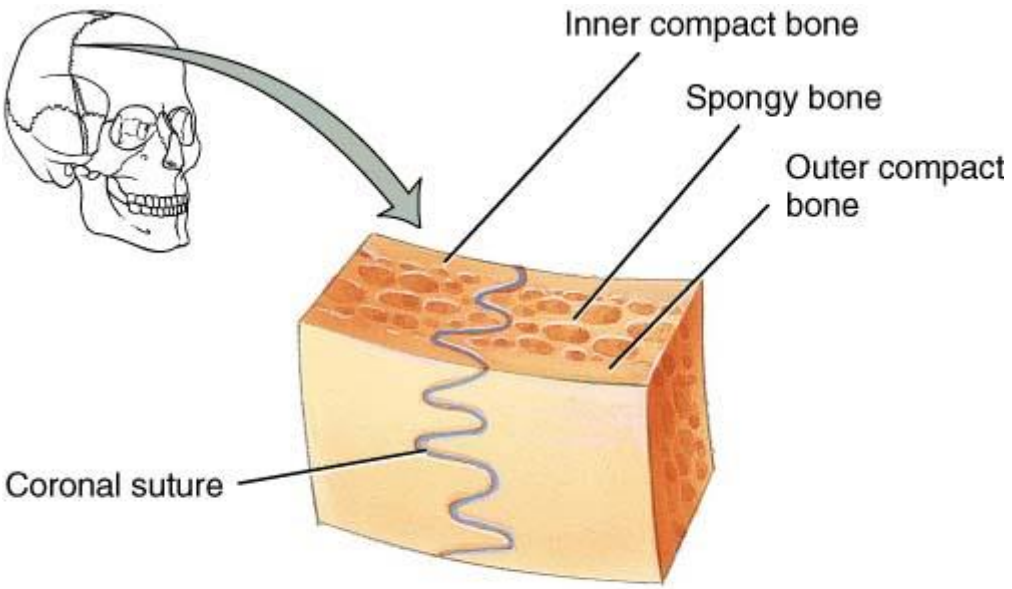
- ***NO*** synovial cavity
- Bones are held together by fibrous ***connective*** tissue, rich in collagen fibres
- Permit ***little*** or ***no*** movement

3 types:

- sutures
- syndesmoses
- gomphoses

i) Sutures

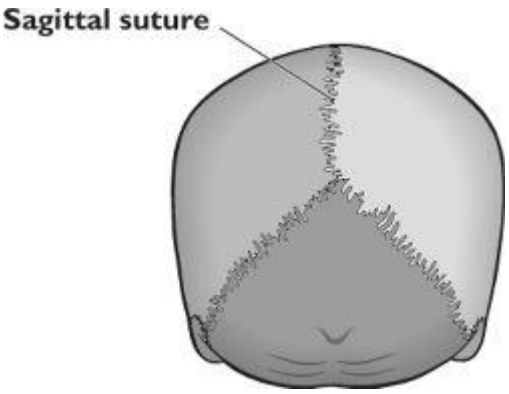
- A ***suture***: a fibrous joint composed of a thin layer of dense fibrous connective tissue
- Occur between bones of the ***skull***
- The irregular ***interlocking*** edges of sutures give them added ***strength*** and decrease their chance of fracturing
- A suture is ***immovable*** (classified functionally as ***synarthrosis***)



(a) Suture between skull bones

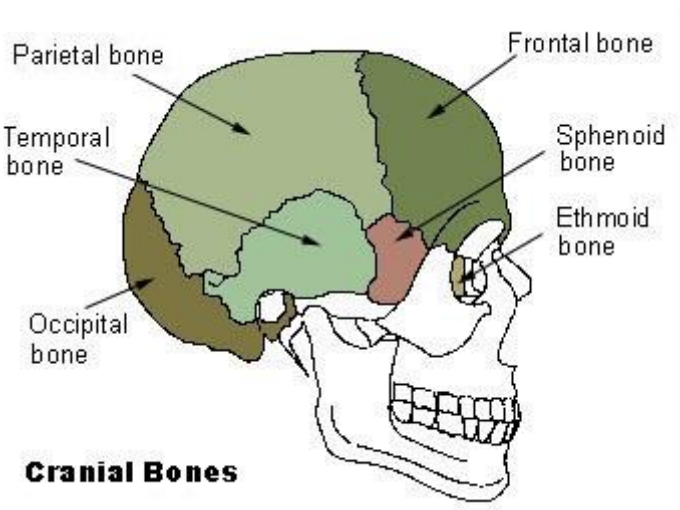
Examples of Sutures 1

- Based on the form of the margins of the bones, several types of sutures can be distinguished:
- ***Serrate*** Sutures
- margins are serrated like the ***teeth*** of a ***saw***, e.g. sagittal suture between the 2 parietal bones



Examples of Sutures 2

- ***Squamous*** Suture
- margin of one bone ***overlaps*** that of adjacent bone, e.g. parietal & temporal bones

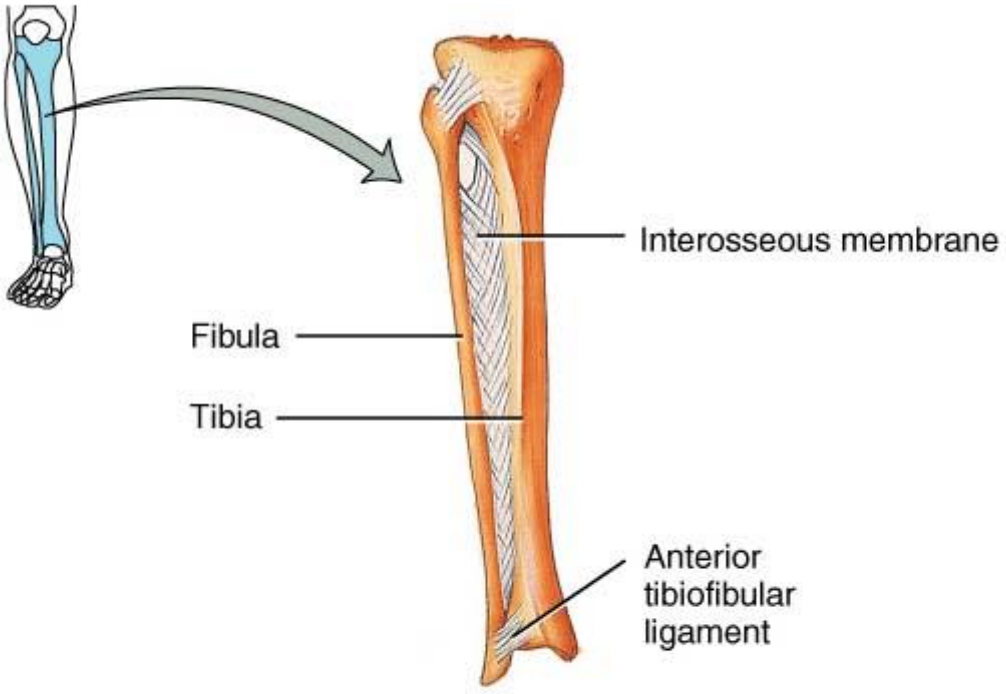


Examples of Sutures 3

- ***Plane*** Suture
- even, fairly regular margins, e.g. lacrimo-maxillary suture

ii) Syndesmoses

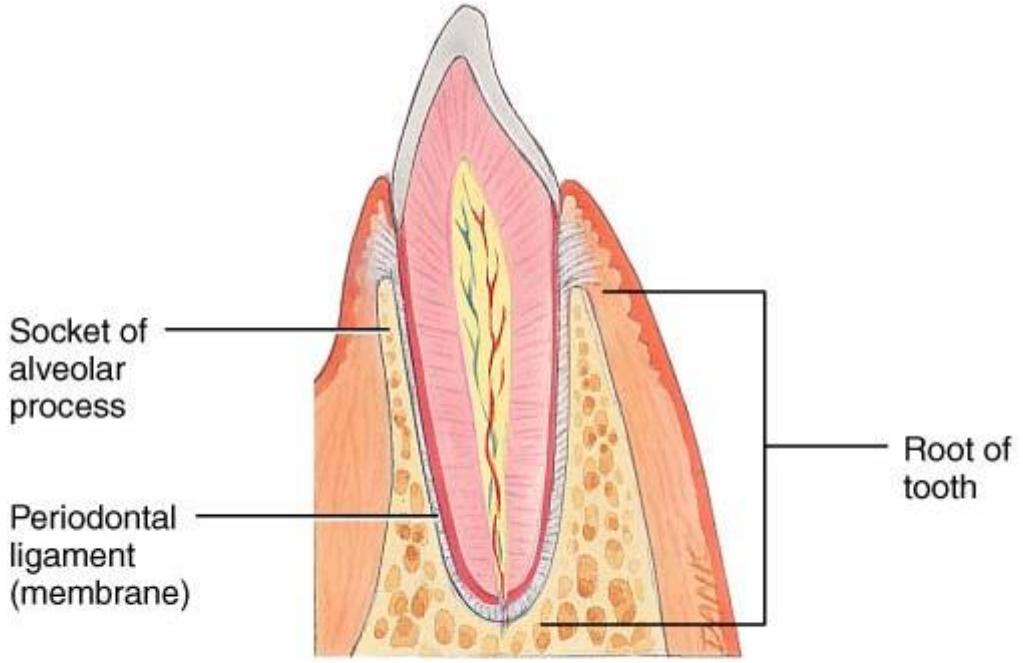
- A ***fibrous*** union between two bones, which are connected by a wide sheet of ***ligament*** –an interosseous ligament or membrane
- e.g. Between the radius and ulna, and the tibia and fibula



(b) Syndesmoses between tibia and fibula

iii) Gomphoses

- Found between a tooth and socket of alveolar process
- A cone shaped peg fits into a socket -the dense ***fibrous connective*** tissue between a tooth and its socket is the periodontal ligament (membrane)
- Functionally classified as a ***synarthrosis***, an ***immovable*** joint
- Inflammation and degeneration of the gums, periodontal ligament and bone is known as periodontal disease



(c) Gomphosis between tooth and socket of alveolar process

Structural Classification: Cartilaginous Joints

- These joints lack a synovial cavity
- ***Little*** or ***no*** movement
- The articulating bones are tightly connected by either hyaline ***cartilage*** or fibrocartilage

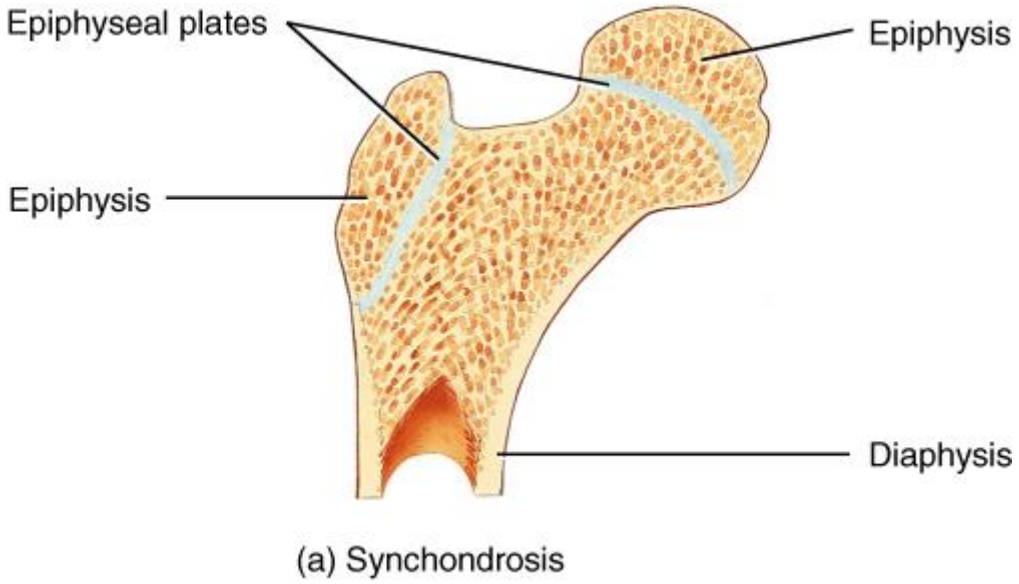
The 2 types of cartilaginous joints are:

- ***synchondrosis***(Primary cartilaginous joints)
- ***symphysis***(Secondary cartilaginous joints)

i) Synchondrosis

- Connecting material is hyaline ***cartilage*** (chondro= cartilage)
- Joint is ***immovable*** and strong

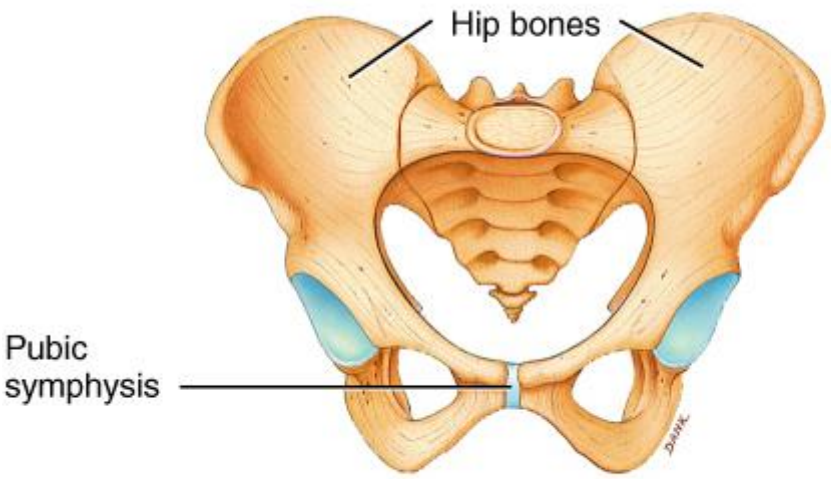
- Some of these joints are ***temporary*** in nature –after a certain age the cartilaginous plate is replaced by bone
- e.g. the ***epiphyseal plate*** that connects the epiphysis and diaphysis of a growing bone:
- when bone elongation ceases, bone ***replaces*** the hyaline cartilage
- the joint between the 1st rib and the sternum, which ossifies during adult life and becomes an immovable bony joint



(a) Synchondrosis

ii) Symphysis

- occurs in the ***midline*** of the body
- ***cartilaginous*** joint in which the ***ends*** of the articulating ***bones*** are covered with hyaline cartilage but there is also a broad, flat disc of ***fibro–cartilage*** between the bones
- A symphysis is an amphiarthrosis-a ***slightly movable*** joint
- e.g. symphysis mentiin the mandible
- pubic symphysis between the anterior surfaces of the hip bones



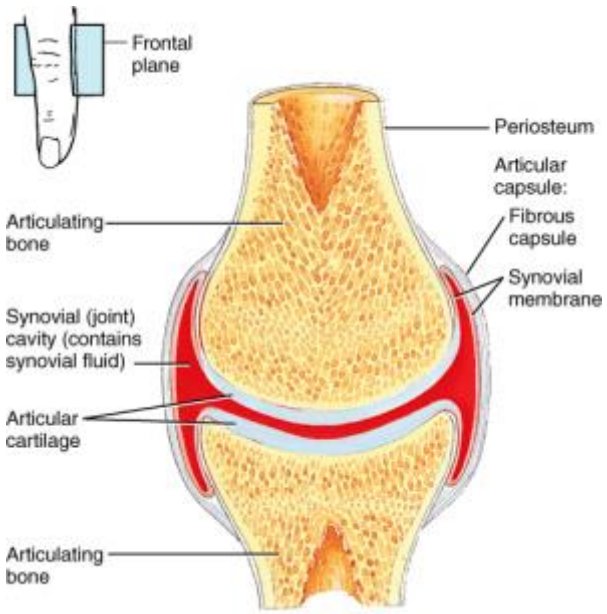
(b) Symphysis

Structural Classification:Synovial Joints

- (Functionally ALL synovial joints are classified as ***diarthroses*** – ***freely*** movable)
- There are some very ***defined*** characteristics of synovial joints which make them different from the other 2 types
- These characteristics are responsible for:
  i) ***stability***
  ii)***movability***

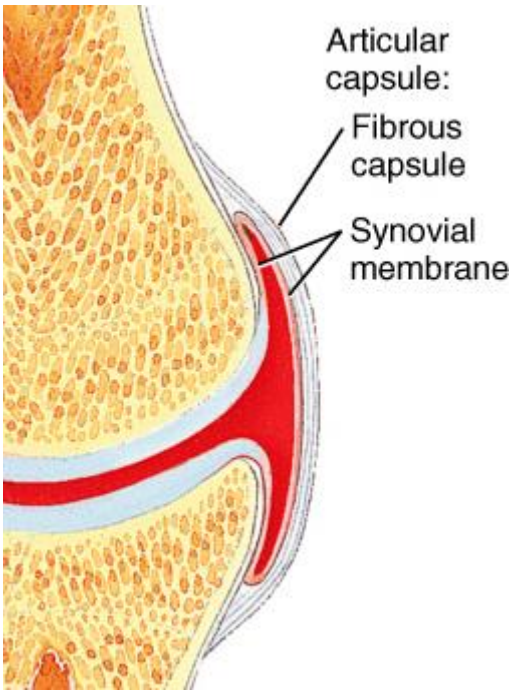
Characteristics -Synovial Joints

- SYNOVIAL ***CAVITY***-a space between the articulating bones
- ARTICULAR ***CARTILAGE***-bones are covered by a layer of hyaline ***cartilage***
- ARTICULAR ***CAPSULE***-sleeve-like; ***surrounding*** a synovial joint; encloses the synovial cavity and unites the articulating bones



Articular Capsule

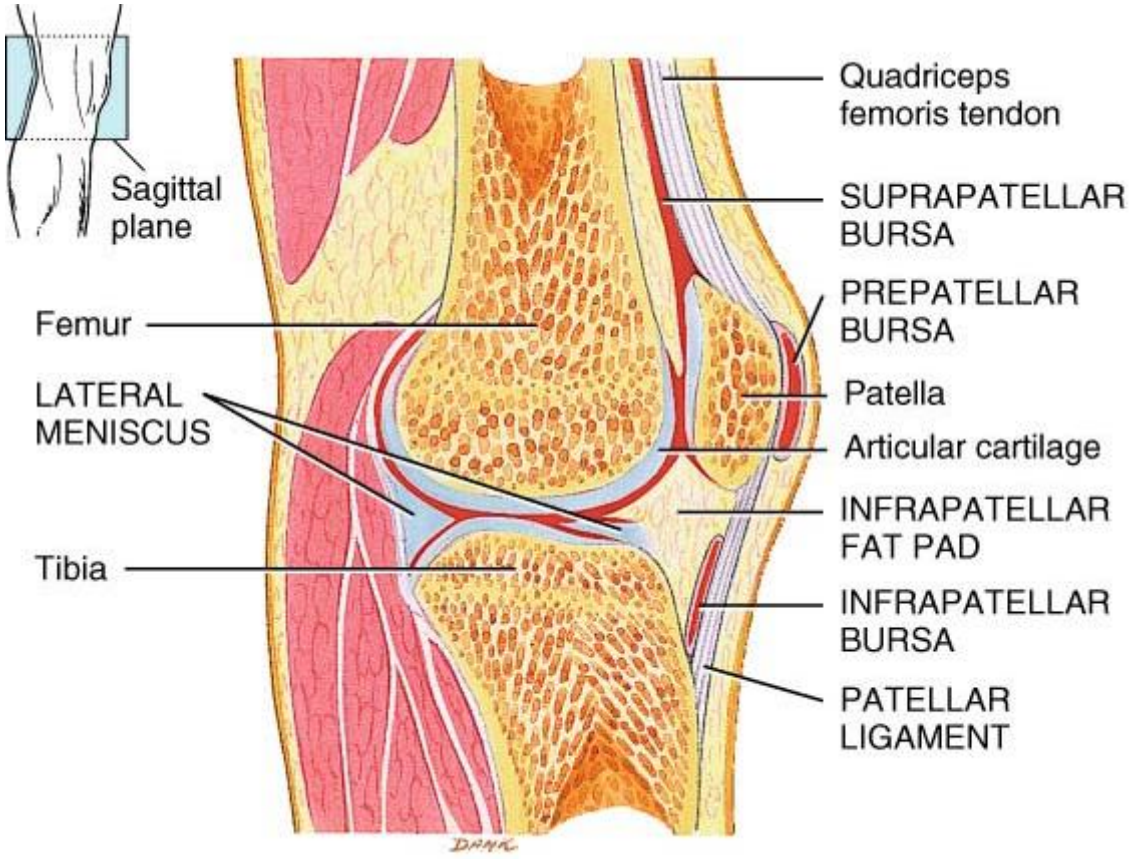
- Composed of TWO layers:
- an outer fibrous ***capsule***
- synovial **membrane**



i) Outer Fibrous Capsule

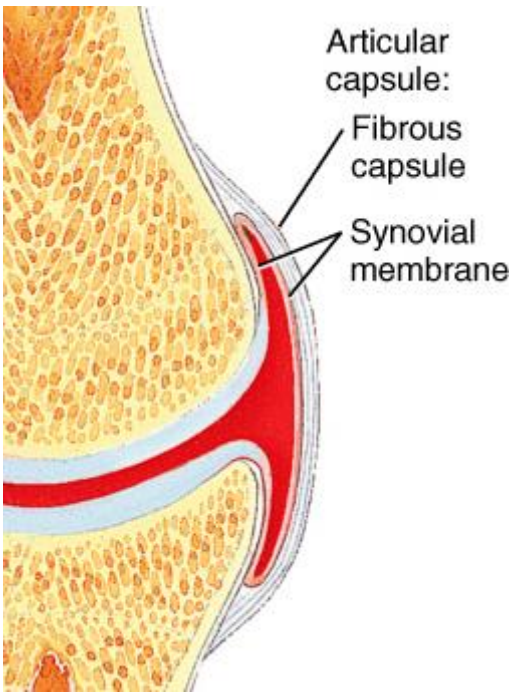
- Attaches to the ***periosteum*** of the articulating bones
- ***Flexible*** -permitting considerable movement of a joint
- Great tensile ***strength*** (resistance to stretching) which helps prevent the bones from dislocating

- ***Fibres*** of some fibrous capsules are arranged as parallel bundles of dense regular ***connective*** tissue -highly adapted for resisting strains
- The strengths of these fibre bundles, called ***ligaments***–are the principal mechanical factor that ***holds bones*** together in a synovial joint



ii) Synovial Membrane

- ***inner*** layer composed of areolar ***connective*** tissue with elastic fibres
- can also include accumulations of adipose tissue, called articular ***fat pads***
- double jointed people -no extra joints but greater flexibility in their articular capsules and ligaments -more likely to 'dislocate' their joints

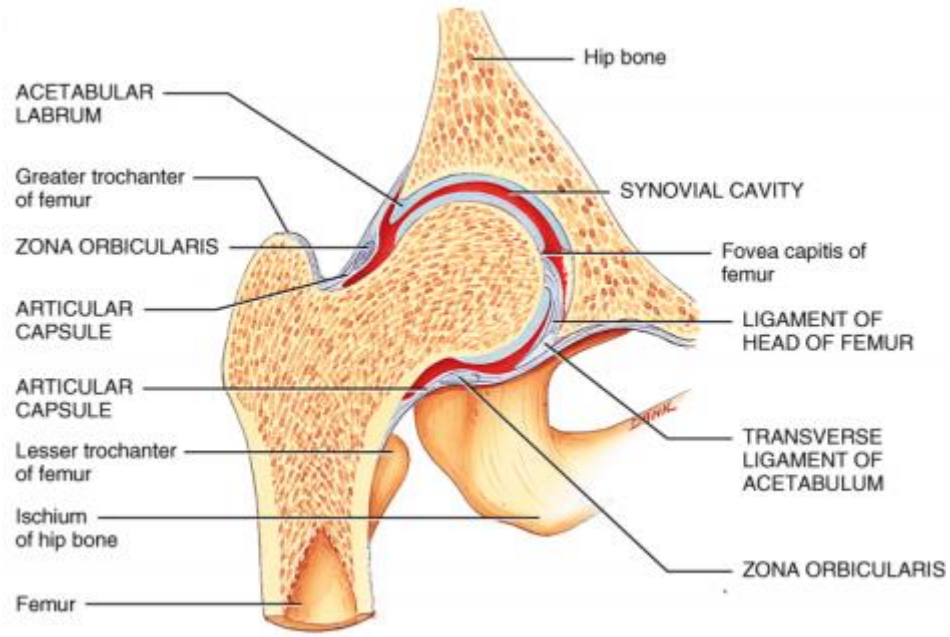


Synovial Fluid

The synovial ***membrane secretes*** synovial ***fluid***: a viscous, clear or pale yellow fluid, consisting of:

- ***hyaluronic acid***, secreted by cells in the synovial membrane and interstitial fluid filtered from blood plasma
- it forms a ***thin film*** over the surfaces within the articular capsule
- ***lubricates*** the joint -reduces friction & absorbs shock
- supplies ***O2*** and ***nutrients***, removes ***CO2*** and metabolic ***wastes*** from chondrocytes within articular cartilage
- phagocytosis -phagocytic cells remove microbes and debris (result of wear and tear)

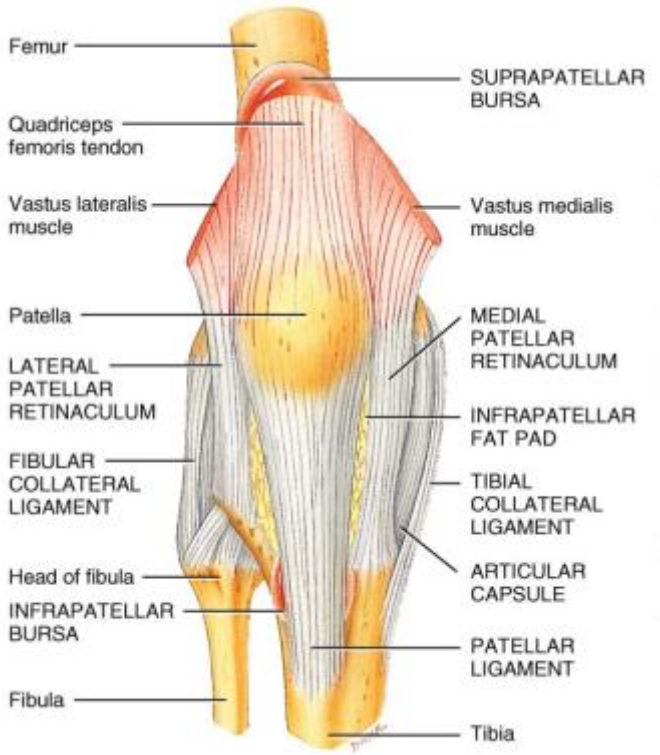
- when ***immobile*** -fluid becomes ***viscous***
- when ***mobile*** -fluid becomes ***less*** viscous
- warm up before exercise!!!
- cracking of knuckles, popping sounds -what is actually happening inside the joint?



Accessory Ligaments

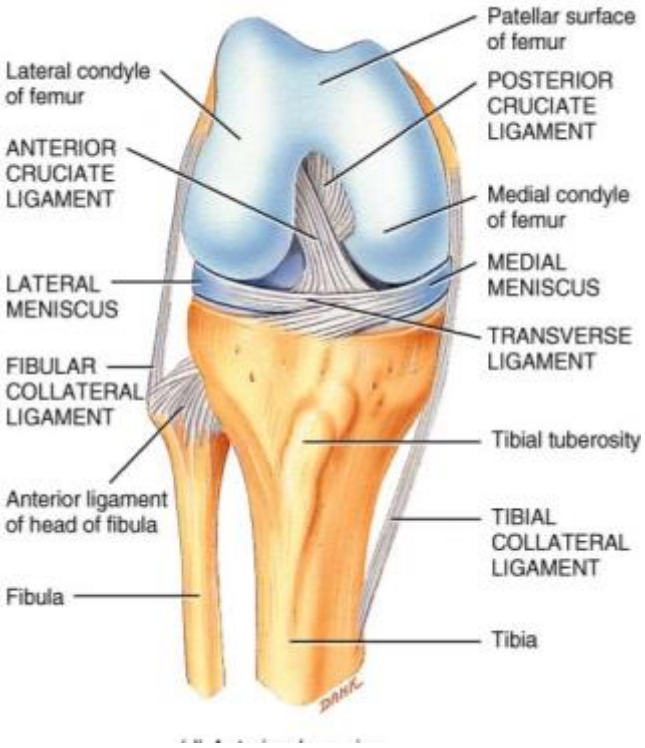
i)Extracapsular ligaments:

- lie ***outside*** the articular ***capsule***
- e.g. fibular and tibial ***collateral ligaments*** of the knee joint



ii)Intracapsular ligaments:

- occur ***within*** the articular ***capsule*** but are excluded from the synovial cavity by folds of the synovial membrane
- e.g. anterior and posterior ***cruciate ligaments*** of the knee joint

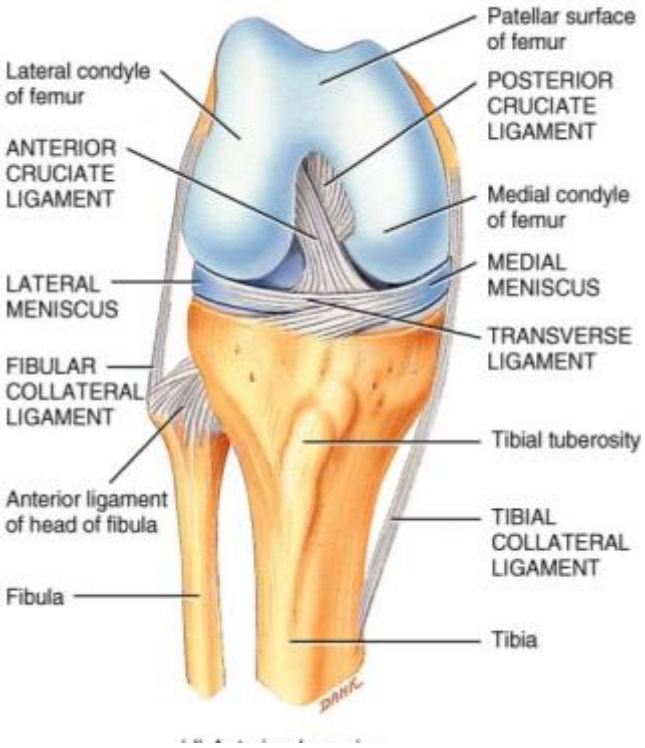


Other Joint Structures

- Articular Discs
- Bursae
- Tendon sheaths
- Ligaments…

Articular Discs

- Articular ***discs*** or menisci(singular -meniscus)
- Pads of fibro-cartilage that lie ***between*** the articular **surfaces** of the ***bones*** and attached to the fibrous capsule, e.g. lateral & medial menisci in the knee joint
- Act as ***shock absorbers***



Articular Discs elsewhere:

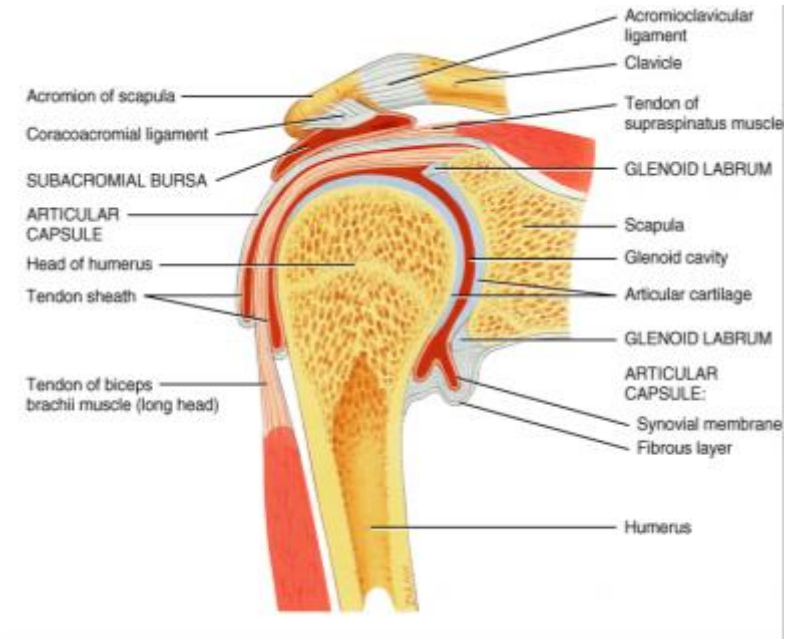
Temporo-mandibular joint (TMJ)

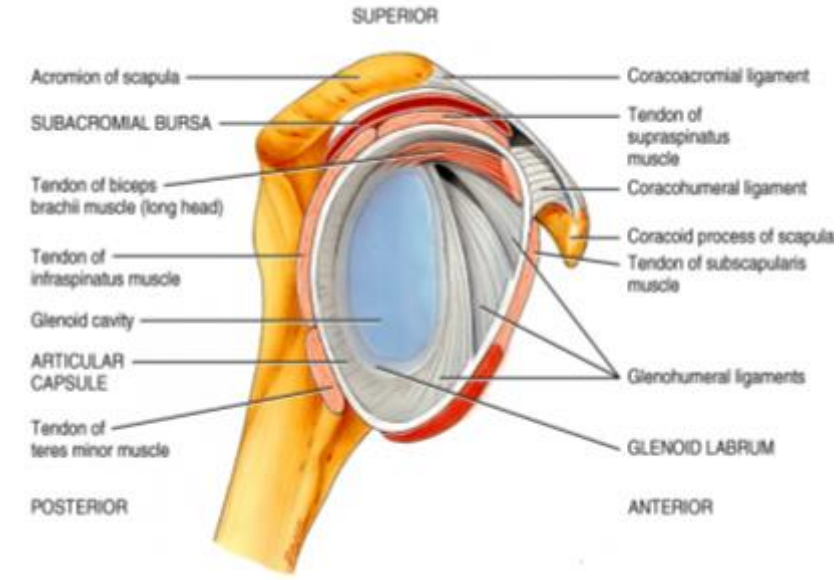
- By modifying the shape of the joint surfaces of the articulating bones, ***articular discs*** allow two bones of ***different*** shapes to ***fit*** together more tightly
- Articular discs also help to maintain the ***stability*** of the joint and ***direct*** the ***flow*** of synovial fluid to the areas of greatest friction

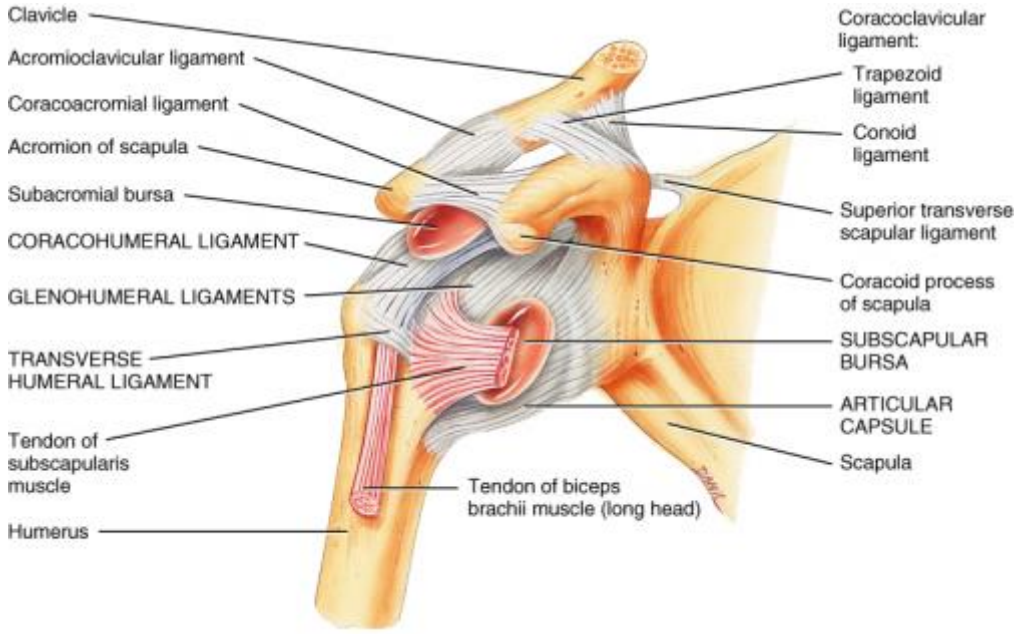
Bursae (Sing. Bursa)

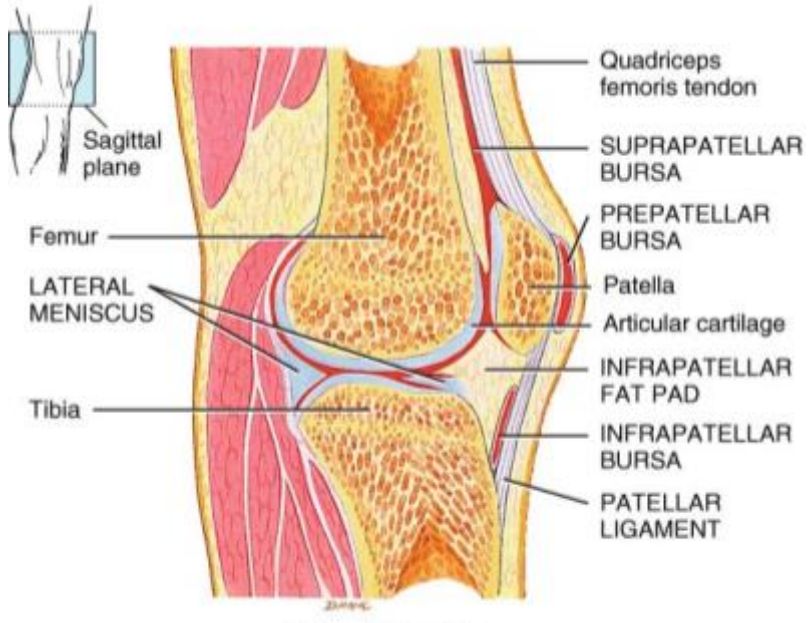
- Saclike, filled with fluid, have ***cushion*** effect
- ***Between*** *bones and:*
- skin
- tendons
- muscles
- ligaments
- Strategically situated to alleviate ***friction*** in some joints, e.g. shoulder and knee joints

- Friction created between moving parts during various movements





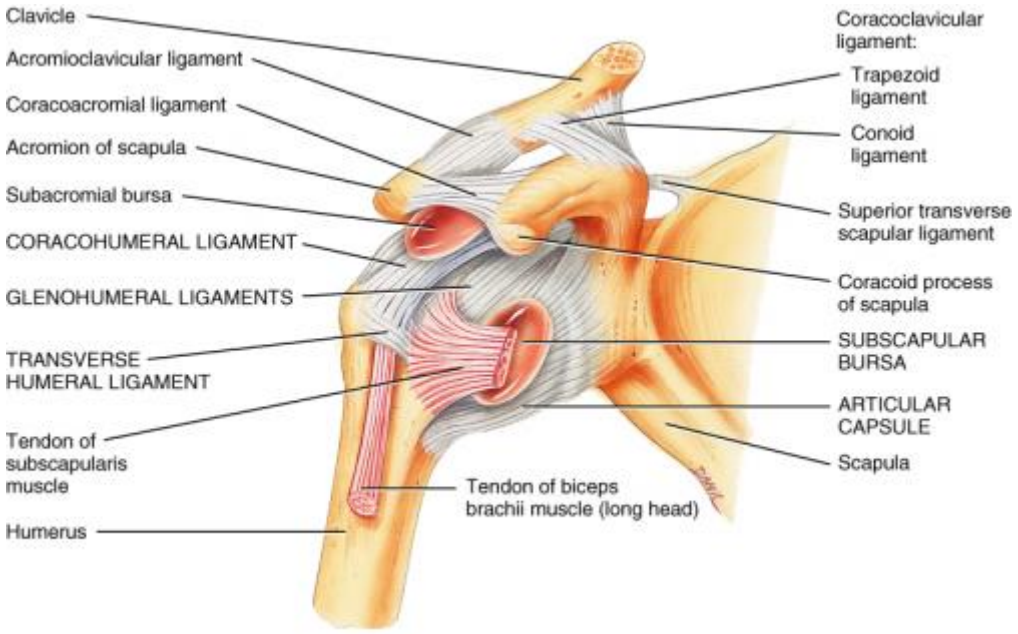




(c) Sagittal section

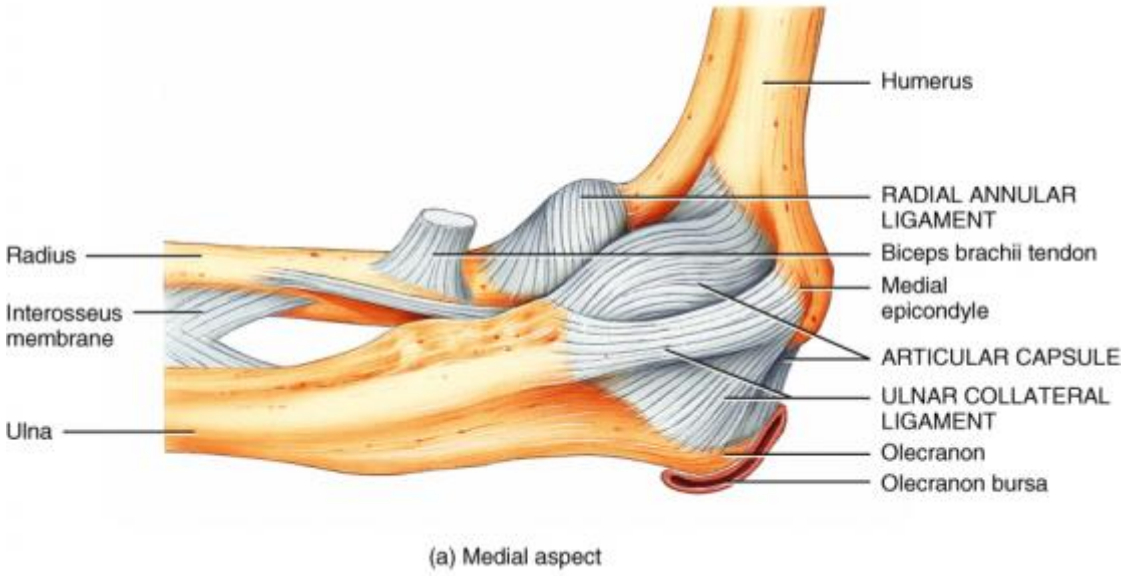
Tendon Sheaths

- Tendons connect ***muscles*** to ***bones***
- Tube like ***bursae*** that ***wrap*** around certain ***tendons*** that experience considerable ***friction***
- Occurs where tendons pass ***through*** synovial ***cavities*** e.g. tendon of the biceps brachii muscle at the shoulder joint

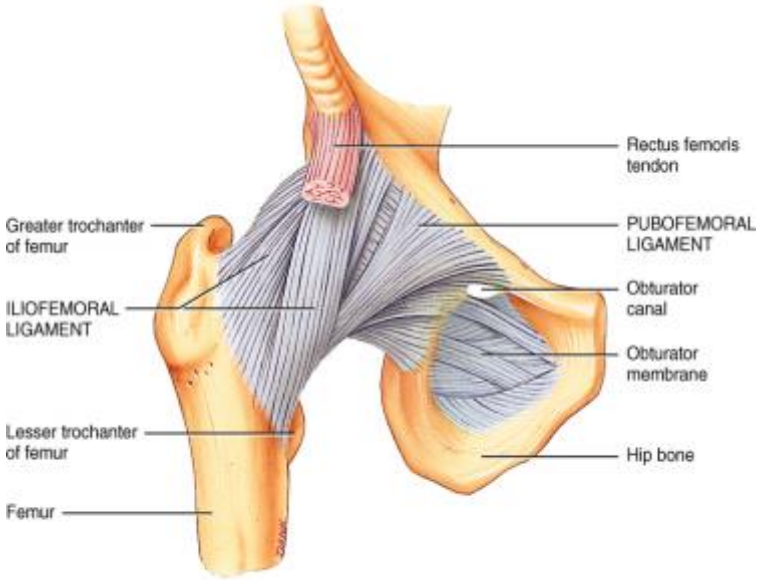


Ligaments

- Ligaments connect ***bones*** to other ***bones*** to form a joint. They do not connect muscles to bones; that is the job of tendons
- Fibrous tissue



(a) Medial aspect



(a) Anterior view

09.13a

Blood Supply

- Many of the components in a joint are ***avascular***
- ***Arteries*** in the vicinity send out numerous branches that penetrate the ***ligaments*** and articular ***capsule*** to ***deliver*** oxygen and nutrients
- Branches from several different arteries ***merge*** around a joint before penetrating the articular capsule

- ***Veins remove*** CO2 and ***waste*** e.g. from chondrocytes > synovial fluid > blood

Nerve Supply

- Synovial joints contain many nerve endings that are distributed to the articular ***capsule*** and associated ***ligaments***
- Information about ***pain*** is conveyed from the joint to the ***spinal cord*** and ***brain*** for processing
- Nerves respond to the degree of ***movement*** & ***stretch*** at a joint
- ***Impulses*** are sent through different nerves to the muscles to adjust body movements

Types of Synovial Joints

SIX broad categories to study:

- 1) ***Planar*** joints: wrist, spine
- 2) ***Hinge*** joints: knee, elbow
- 3) ***Pivot*** joints: proximal radio-ulnar joint; distal radio-ulnar joint
- 4) ***Condyloid*** joints: metacarpo-phalangeal joints
- 5) ***Saddle*** joints: sterno-clavicular joint
- 6) ***Ball and socket*** joints: hip, shoulder

NB:
•You need to learn the features of the joints of the body and their landmarks (i.e. how do we know where to direct the X-ray beam?)

CATEGORIES

Appendicular (6)

Axial (8)

Basic Xray Physics (5)

CT (3)

Introduction to Physiology (8)

Patient Information (16)

Systems (19)

Textbook (18)

Xray Imaging Science (21)