VETS6104 Foundations of Veterinary Science Notes
Locomotion & Posture Module Theory

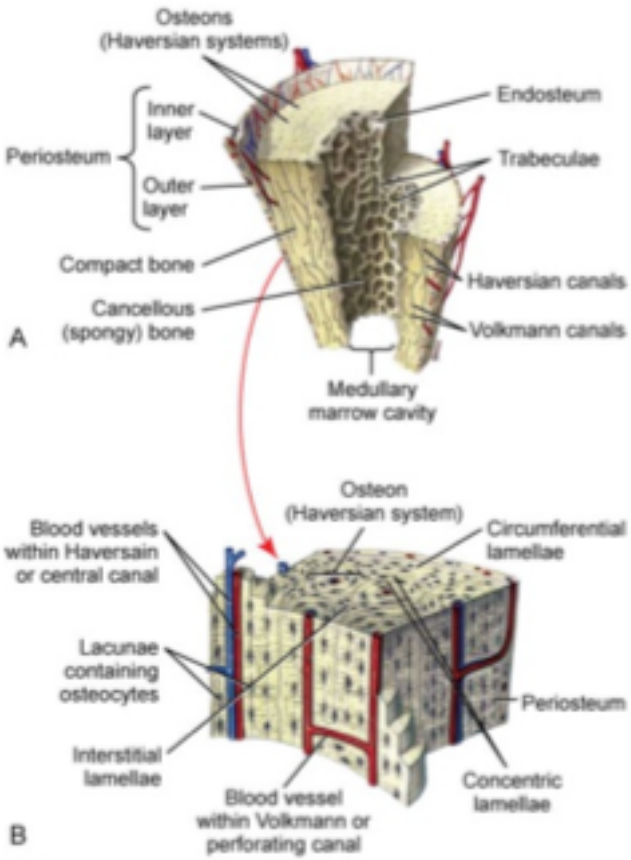
Table of contents:

Gross anatomy lecture: Concepts of biomechanics

All tissues derive from a single embryological origin → MESODERM
All tissues comprise the same elements:

- Cells
- Extracellular matrix (produced by cells)
- Fibres
- Water

Variations in types/relative amounts of cells and matrix have a huge impact upon gross material properties of each tissue

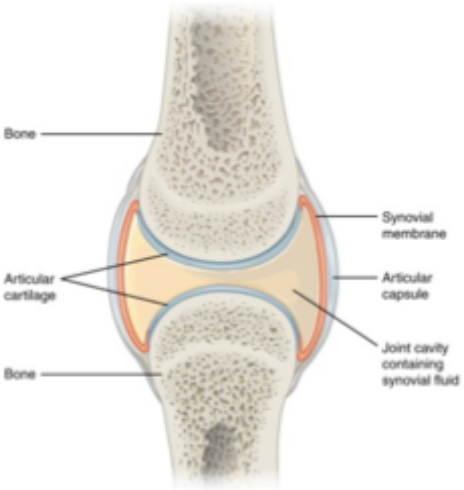


Bone:

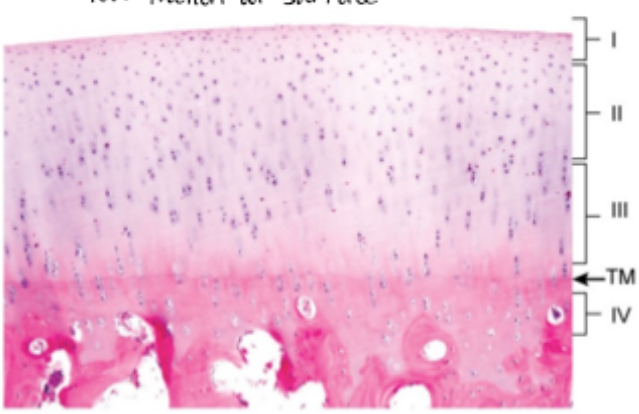
- 70% mineral (mineralised matrix) which hydroxyapatite crystals are laid down upon
- Highly ordered collagen fibres
- Relatively low numbers of cells
- Extremely strong and stiff
- Mineral provides strength in compression
- Collagen provides strength in tension

Cartilage:

- Scant cells embedded in matrix
- Matrix not mineralised
    - Contains proteoglycans
    - Very hydrophilic
    - Web of fibres prevent over-expansion
- Spongy tissue
- Deforms when compressed
- Very strong in compression
- Very low friction



low friction at surface



Dense connective tissue:

- Ligaments, fascia, tendons
- Almost entirely made up of collagen
    - Oriented parallel
- Small number of cells and proteoglycans
- No resistance to compression
- Flexible
- Excellent strength in tension
- Tendons = muscle-bone
- Ligaments = bone-bone

Loose connective tissue:

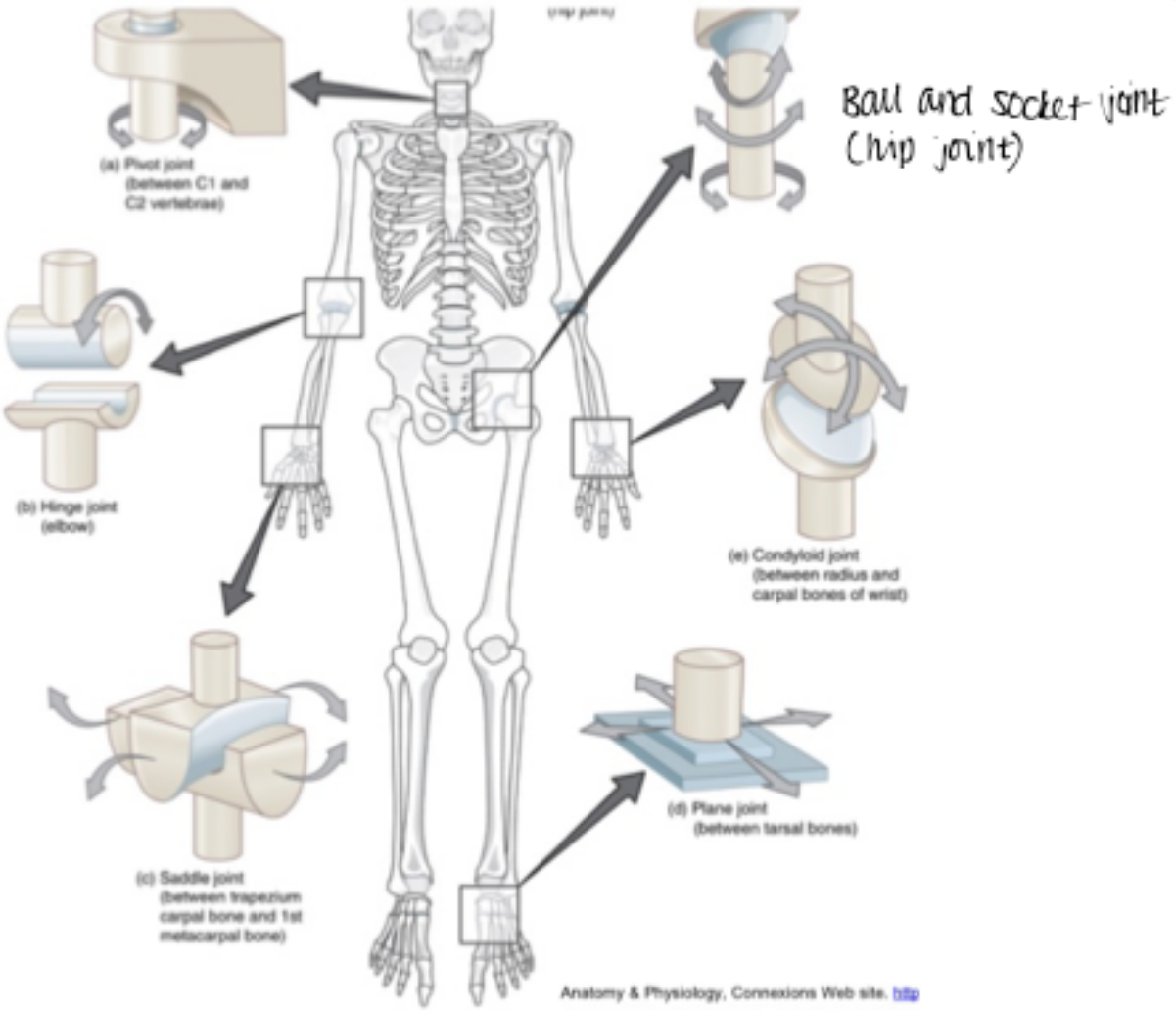
- (Adipose tissue)
- Loose arrangement of fibres
    - Often elastic fibres + water
- No appreciable strength
- Can cushion organs/structures and keep them in place
- Storage (adipose)

Muscle:

- Cells (sarcomere)
- Contains contractile proteins
- Fibres in muscle sheath and tendon
- Minimal matrix
- Only contractile cells are capable of moving the skeleton
- Bulkier and require more energy than other tissues

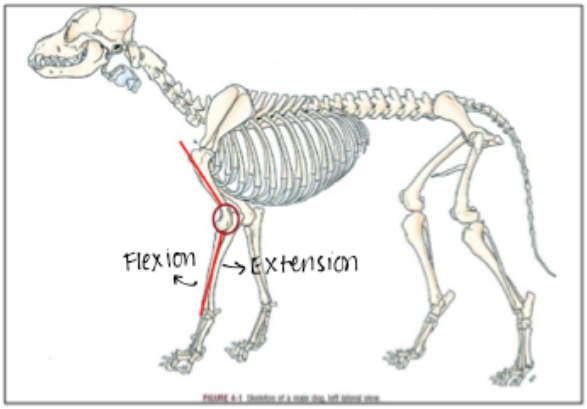
Joints:

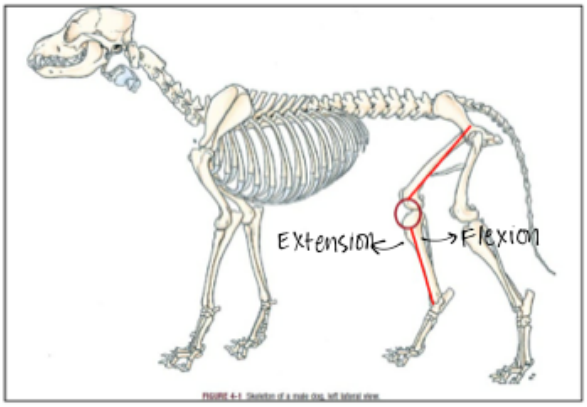
- Syndesmosis = fibrous joints
    - Slow little/no motion
    - Called sutures when matured
- Synchrondrosis (cartilaginous joints)
    - Allowed limits motion
- Synovial
    - Articular cartilage covers bone both ends
    - Ligaments/joint capsule joins bone to bone to restrict motion

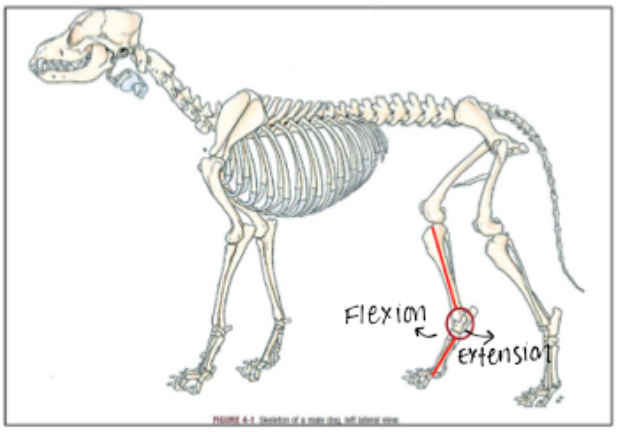


Hinge joint (elbow):

- Flexion = two axes of adjacent bones move closer together
- Extension = two axes of adjacent bones move further apart







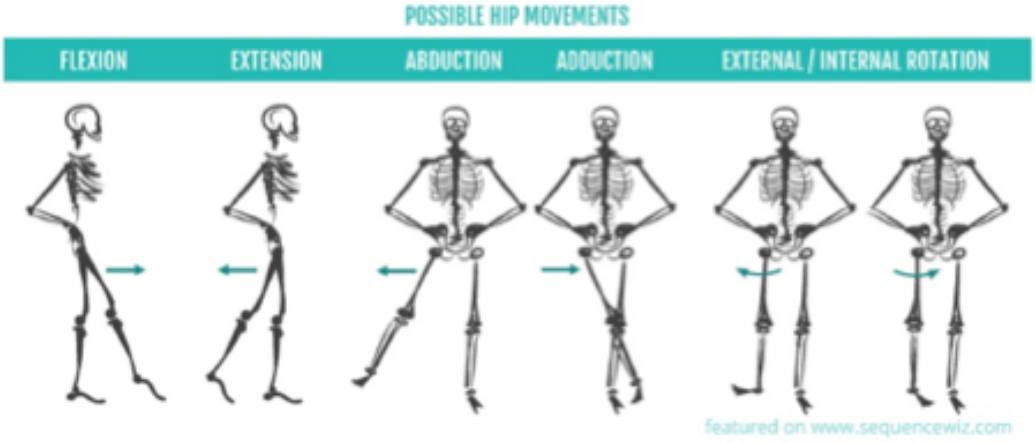
Constraints of a joint:

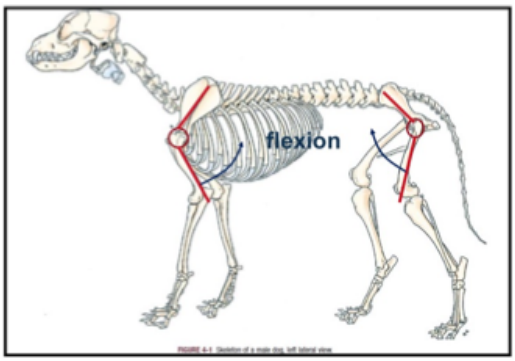
- Congruity of opposing bone surfaces (how well they fit together)
- Dense connective tissues (ligaments and joint capsule)

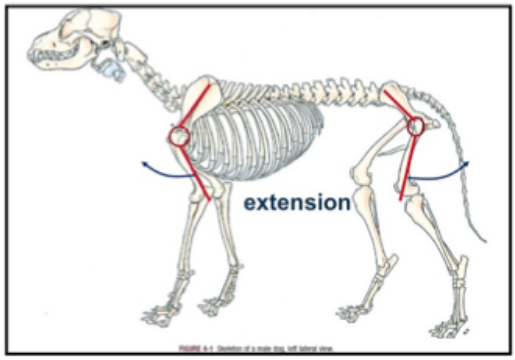
Hinge joints:

- Flexor muscles = on flexor aspect (shorten on flexion)
- Extensor muscle = on extensor aspect (shorten on extension)
    - “Antagonistic pairs” (one contracts, other relaxes)
    - Extensors = bigger and responsible for maintaining upright position
- Muscles span across the joint
- ORIGIN = proximal attachment of muscle
- INSERTION = distal attachment of muscle

Ball-and-socket joints:







- Abduction = movement *away* from the midline
- Adduction = movement *towards* the midline

More motions require more muscle groups
Distributing muscles proximally provides a mechanical advantage
    Limbs can be move forwards/backwards more rapidly
    Increases maximum speed of the animal
Brain receives sensory information → movement initiated and coordinated by the brain
Signal (action potential) propagates
- Down spinal cord
- Through peripheral nerve
- To neuromuscular junction

Musculoskeletal system = effector + provides sensory information to the brain → proprioception

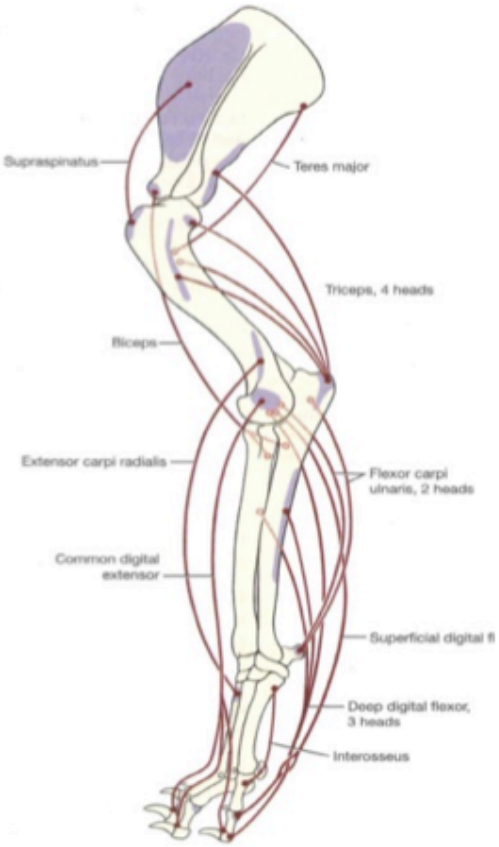


Fig. 2-27 Major extensors and flexors of left forelimb.

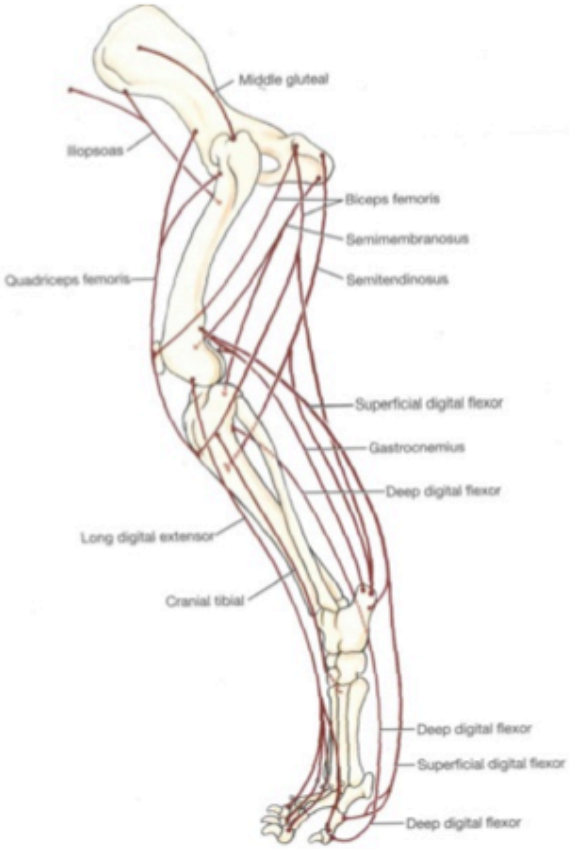
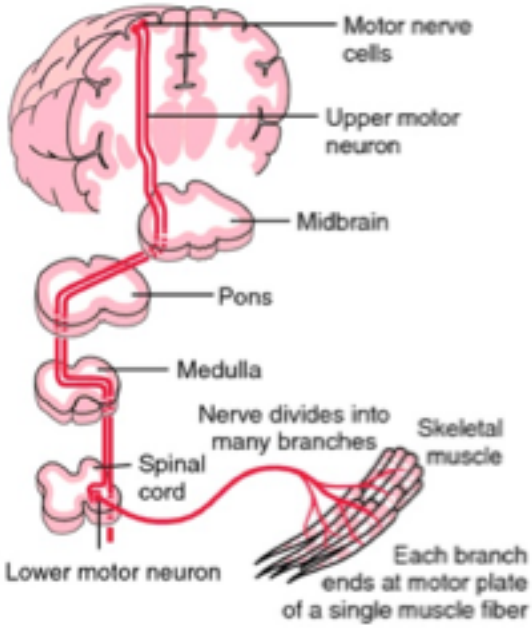
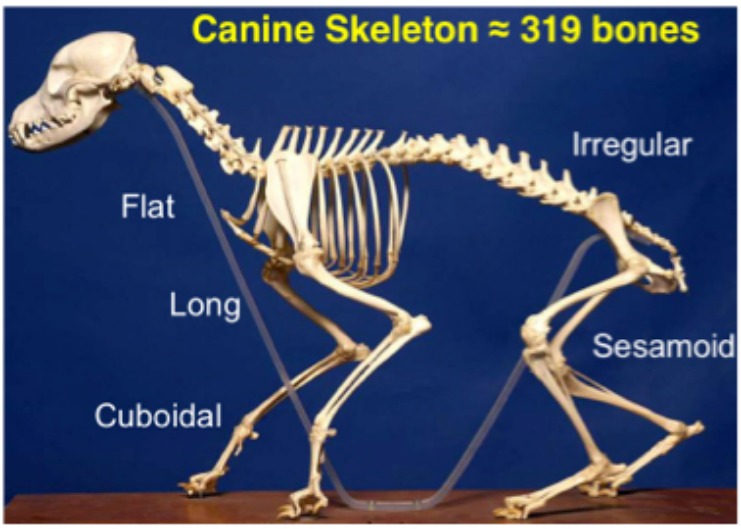


Fig. 2-57 Major flexors and extensors of pelvic limb.



Gross anatomy lecture: Bone structure



There are many similarities between different species in terms of bones
Vary quite a lot in shape and size
Long bones ≈ cylindrical e.g. humerus
Irregular bones e.g. vertebrae
Flat bones e.g. mandible and scapula
Cuboidal bones e.g. carpus and tarsus
Sesamoid bones e.g. patella

Function of bones:

- Structural support
- Lever for muscles
    - Lever arms for muscular contraction

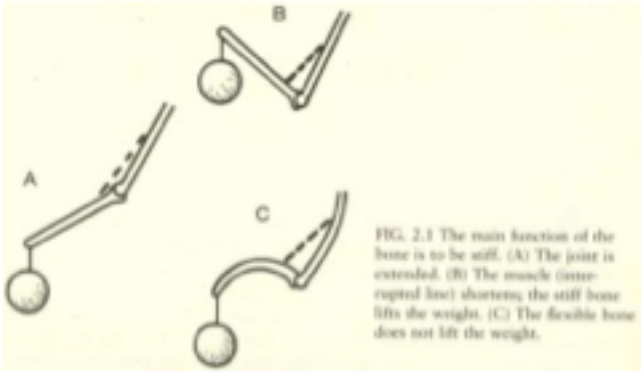
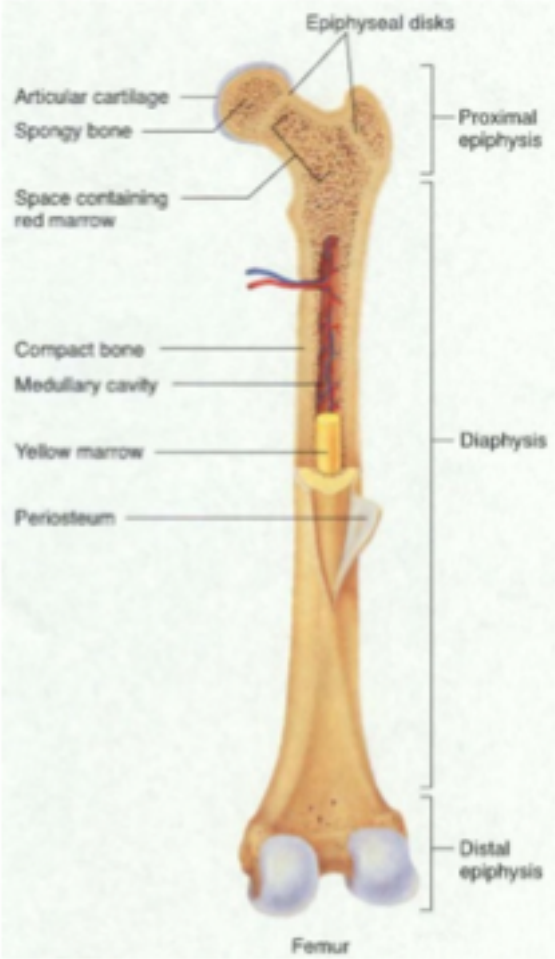


FIG. 2.1 The main function of the bone is to be stiff. (A) The joint is extended. (B) The muscle (interrupted line) shortens; the stiff bone lifts the weight. (C) The flexible bone does not lift the weight.

- Protect organs – viscera and spinal cord
- Bone marrow – haematopoeisis (stem cells)
- Reservoir for calcium
    - So that serum calcium can be maintained at a certain level

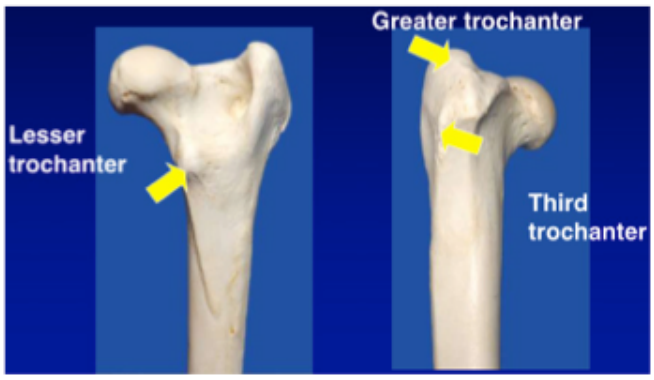
Regions of long bones:

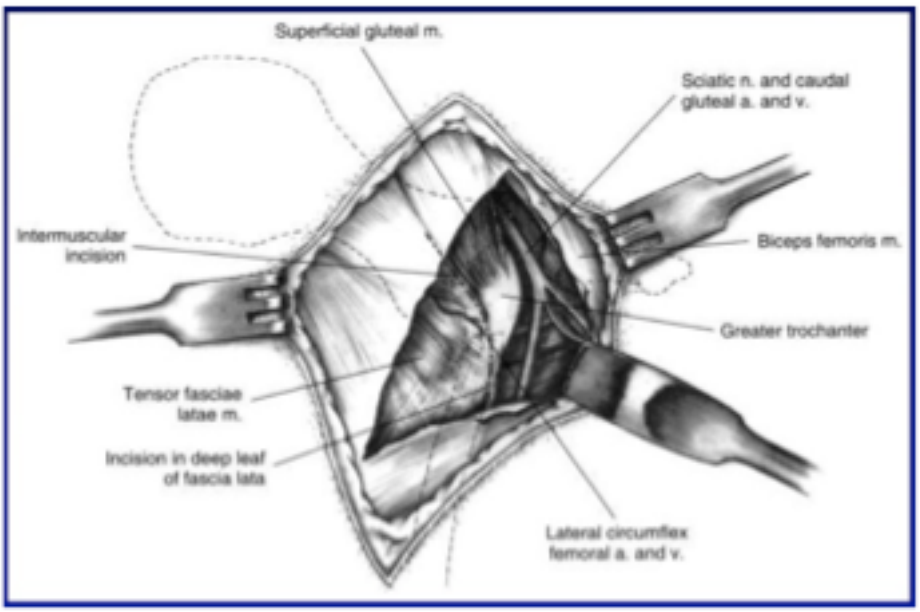


- Diaphysis = shaft
- Epiphysises = centres of ossification
- Medullary cavity = where bone marrow is
- Periosteum = soft tissue on outside of bone

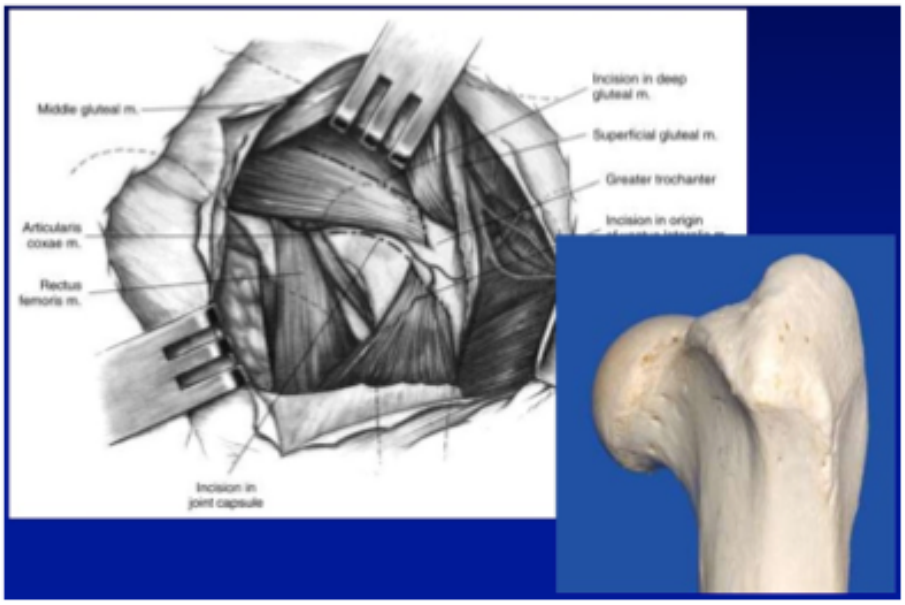
Anatomical features of bony prominences:

- Bony prominences = sites of attachment for soft tissue (muscle etc) so it can serve a mechanical function
- Proximal end of femur:



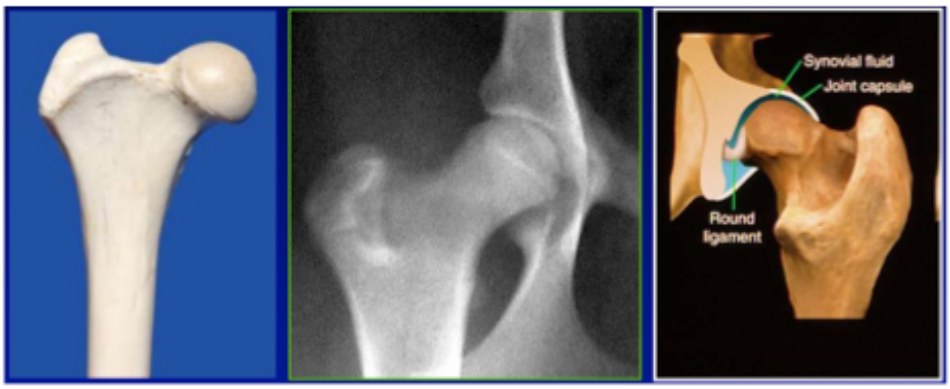


- Bony prominence = greater trochanter
    - Attachment of gluteal muscles



Synovial joint surfaces:

- Ends of bones = covered in specialised tissue (articular cartilage)



- Black line = articular cartilage

The hip joint:

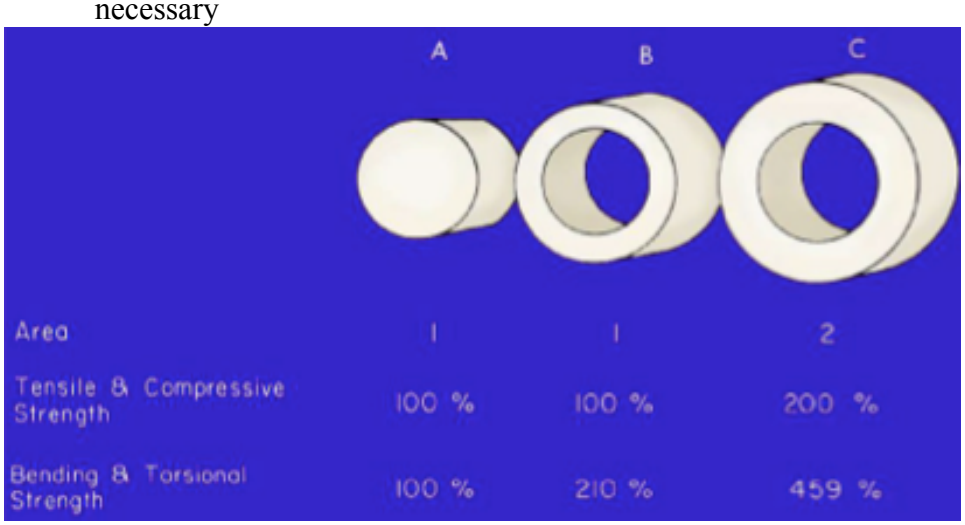
- Back and socket joint
- Joint capsule
- Articular cartilage
- Fibrocartilage labrum
- Ligament of the head of the femur

Specialised attachments → soft tissue → ligament, tendon, horn

- Horn attached to bone at a porous-like site
- Soft tissues of bones:
    - Periosteum = source of bone growth and repair
    - Endosteum = thin vascular membrane of connective tissue that lines the surface of the bony tissue that forms the medullary cavity of long bones
    - Bone marrow
    - Growth plates = where bone elongates

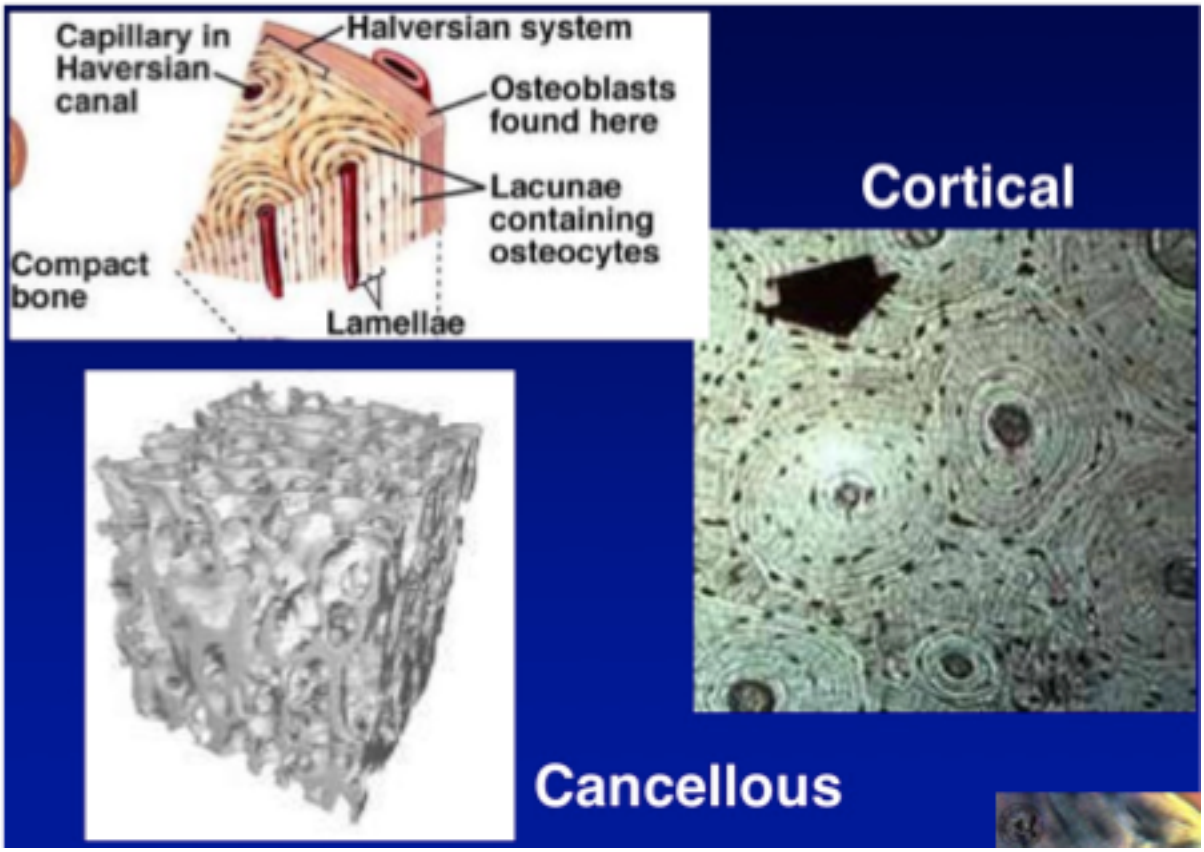
Bone size and shape: compressive, bending and torsional strength:

- Long bones = hollow cylinders
- Mechanical reason for this
- Hollow cylinder = more efficient structure in terms of providing maximum strength for a given weight
- More efficient use of material → don't want more weight in the bones than necessary



Bone structure:

- Living tissues of cells are constantly forming and resorbing bones
- Two main types of bone form a microscopic perspective
- Two main types of bone from a microscopic perspective:
    - Cortical bone = in shaft
    - Cancellous bone = in epiphyses



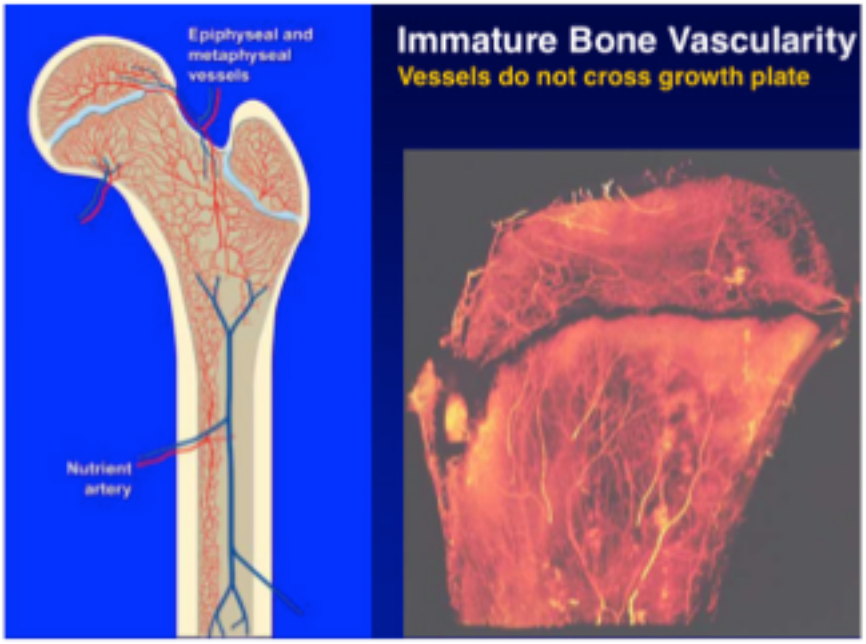
Bone matrix:

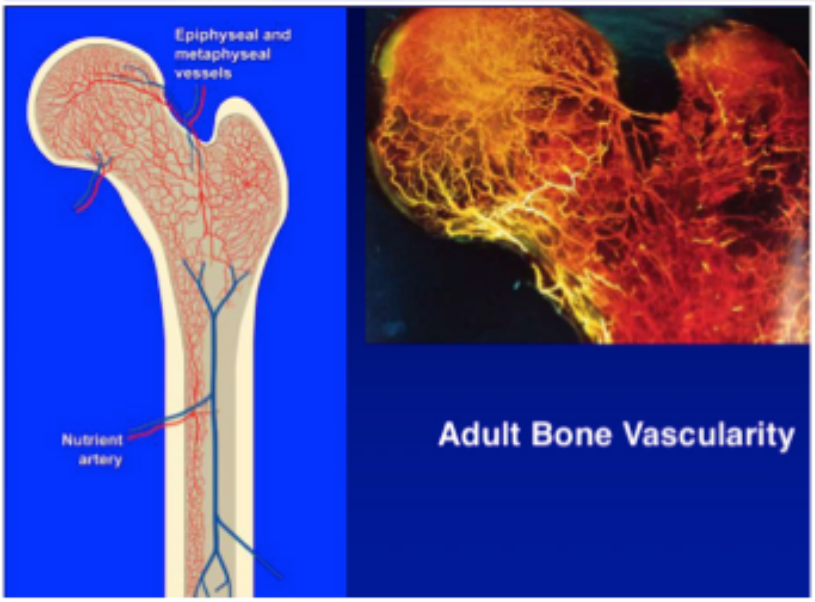
- 60-70% mineral
- Hydroxyapatite crystals
    - Embedded in organic matter
        - Type I collagen
        - Water
    - Parallel arrangement of collagen fibres → aligned along lines of tissues
    - Collagen + hydroxyapatite = highly organised and reflect mechanical strength of bones
- Bone matrix = anisotropic (non uniform in its internal arrangement)
    - Due to arrangement of collagen fibres and hydroxyapatite crystals
- Circularly arranged collagen fibres = osteones
- Related to mechanical properties of the bones
- Highly organised internal structure of bone → doesn't function as a complete functional homogenous material
    - Often get fractures → different types of fracture patterns based on the gross arrangement and microscopic internal arrangement of bone

Bone vascularity:

- Vessels do not cross growth plates
- Nutrient foramen = where nutrient artery gains access into the bone
- Growth plates = usually avascular
- Need separate blood supplies for metaphysis and epiphysis
    - Need an entry point into the bone (foramen)
- When growth stops, growth cartilage → bone

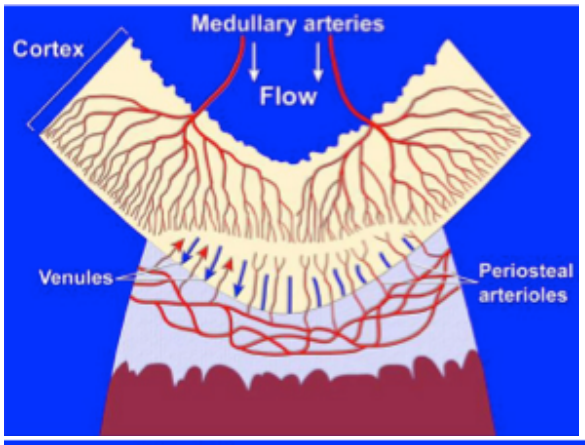
- Metaphyseal vessels coalesce with epiphyseal vessels

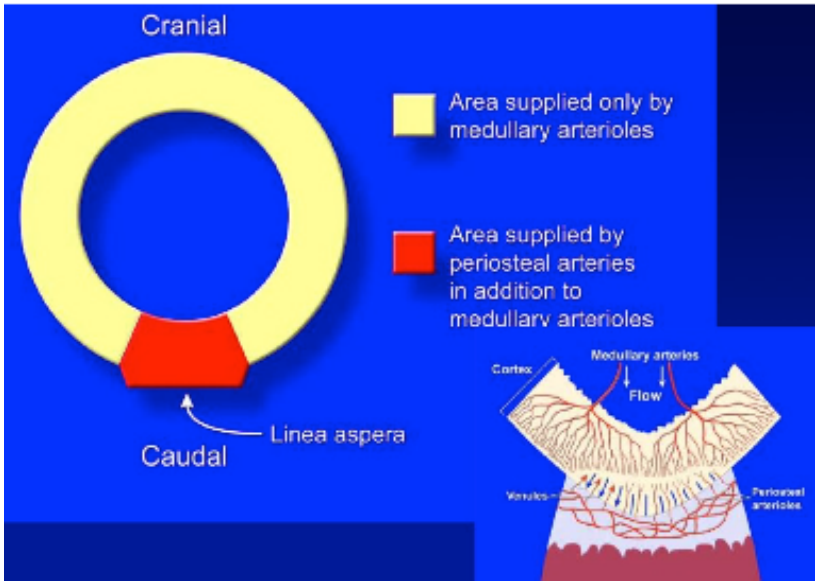




Medullary artery supply:

- Centrifugal blood flow to cortex
- Flowing from endosteal surface to periosteal surface
- Most of the supply of the cortex of the bone go from the inside to the outside
- Different at muscle attachment sites
- Reverse flow – from outside to in





Important to preserve soft tissue attachments in healing

Nutrient artery disrupted in fracture → loss of blood