

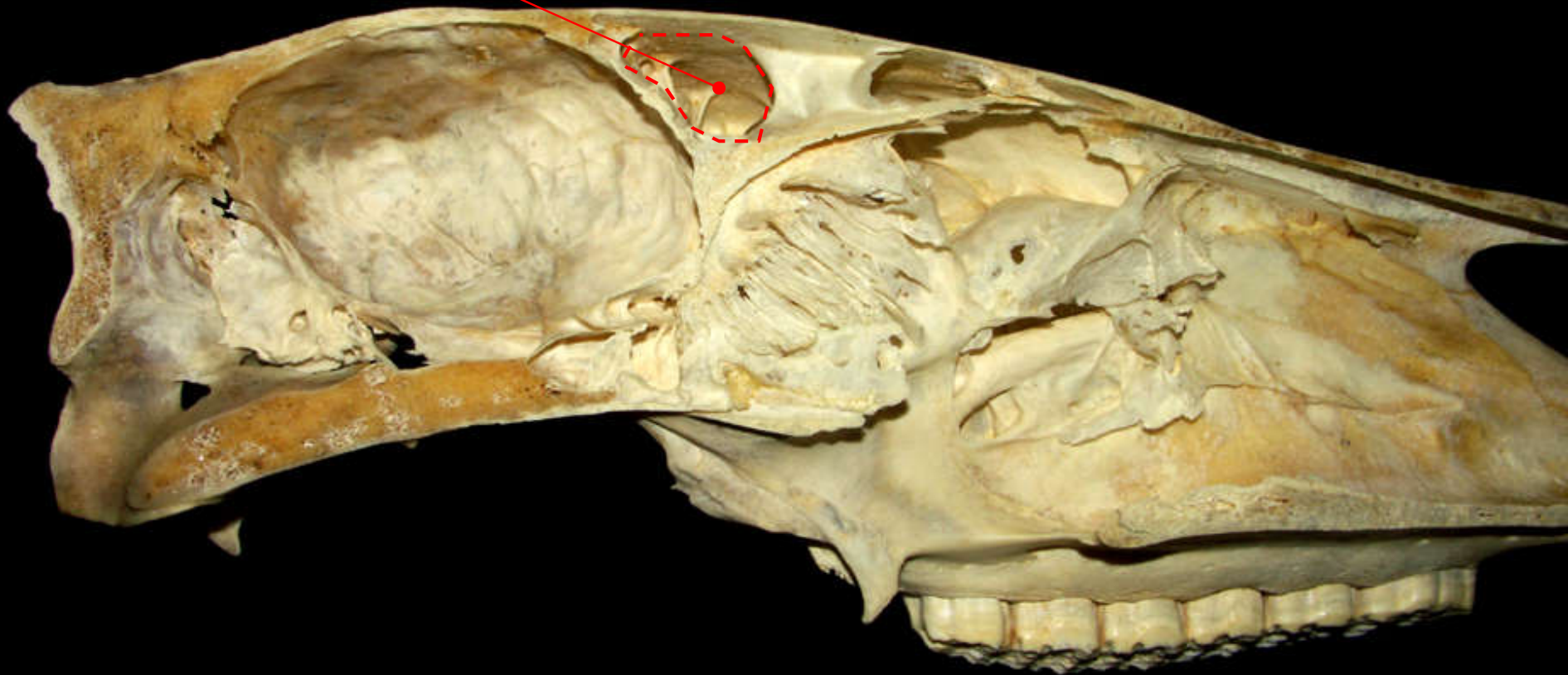
- **Specialized Bones**

- **Pneumatic Bones**

- **Bones which are excavated to provide air spaces**
 - **Examples: paranasal sinus of mammals, bird skeleton**

Pneumatic Bones

Frontal
Sinus



- Origin of the Thoracic Limb
 - Thoracic limb bud
 - Formed within ectoderm
 - Initially consists of a mass of mesenchyme (loose embryonic connective tissue)

Comparative Anatomy of the Thoracic Limb

- Origin of the Thoracic Limb
 - Cartilaginous models formed from mesoderm
 - Cartilage is replaced by bone NOT transformed into bone
 - Ossification
 - Two stage process
 - Intramembranous ossification- primitive periosteum around the middle of the shaft lays bone down on the cartilage
 - Endochondral ossification- cartilage cells hypertrophy and die while matrix is impregnated with calcium salts

Mesenchyme

Cartilage

Hypertrophic chondrocytes

Osteoblasts (bone)

Blood vessel

Proliferating chondrocytes

Epiphyseal cartilage

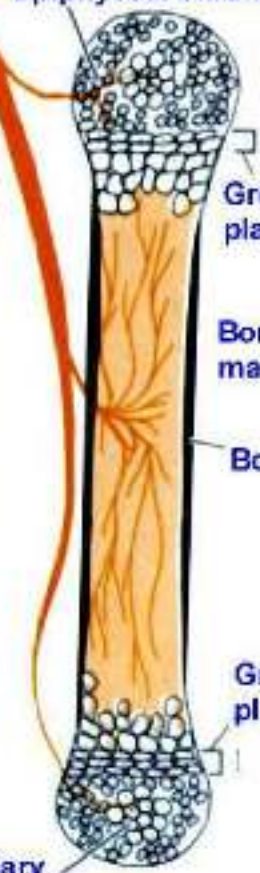
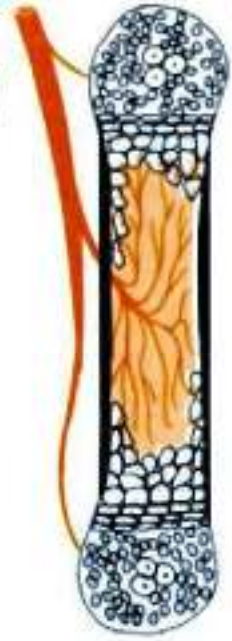
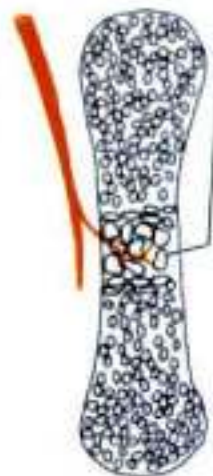
Growth plate

Bone marrow

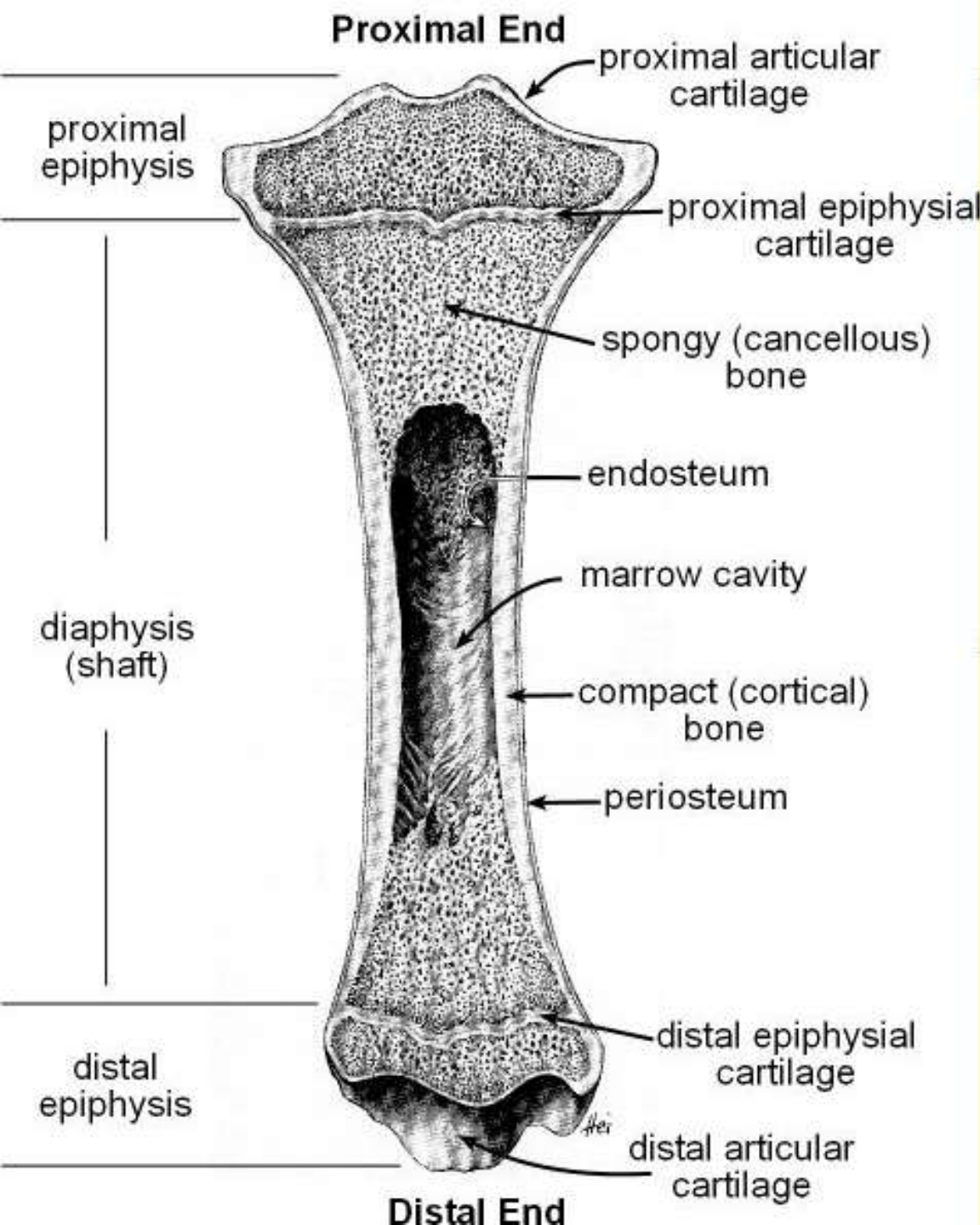
Bone

Growth plate

Secondary ossification center



- Origin of the Thoracic Limb
 - Ossification
 - Initially occurs in the shaft of long bones
 - Epiphyses ossify later



**Canine left
scapula
Lateral View**



**Feline left scapula
Lateral View**



**Hamate
Process**

**Suprahamate
Process**

An additional suprahamate process is found in the cat



Acromion
Process

**Bovine left scapula
Lateral view**

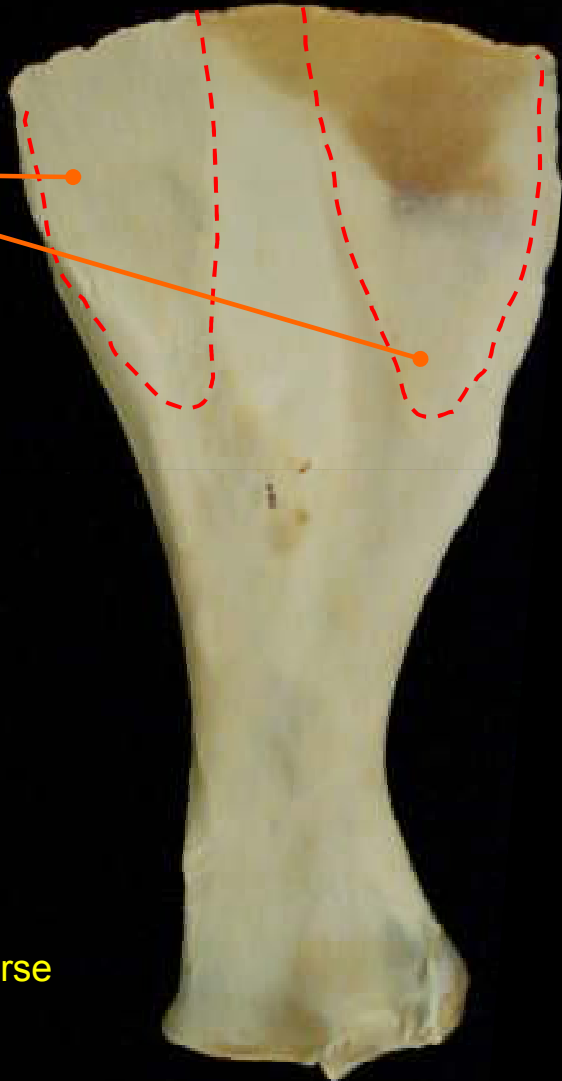


The acromion is absent
in the pig and the horse



**Equine left scapula
Lateral view**

**Equine left scapula
Medial View**

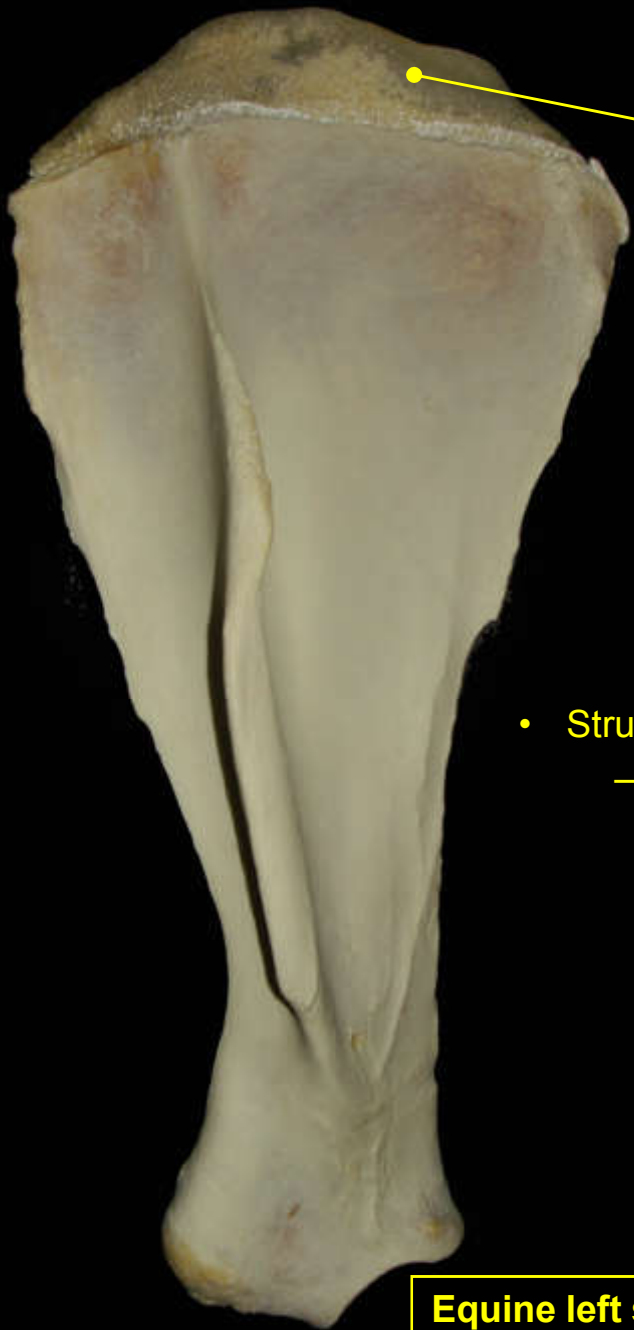


**Serrated
Face**

- a divided serrated face is present in the horse

**Canine left scapula
Medial View**





Scapular
Cartilage

- Structures of the dorsal border
 - **Scapular** cartilage in ungulate and horses

Equine left scapula
Lateral View



Lateral View



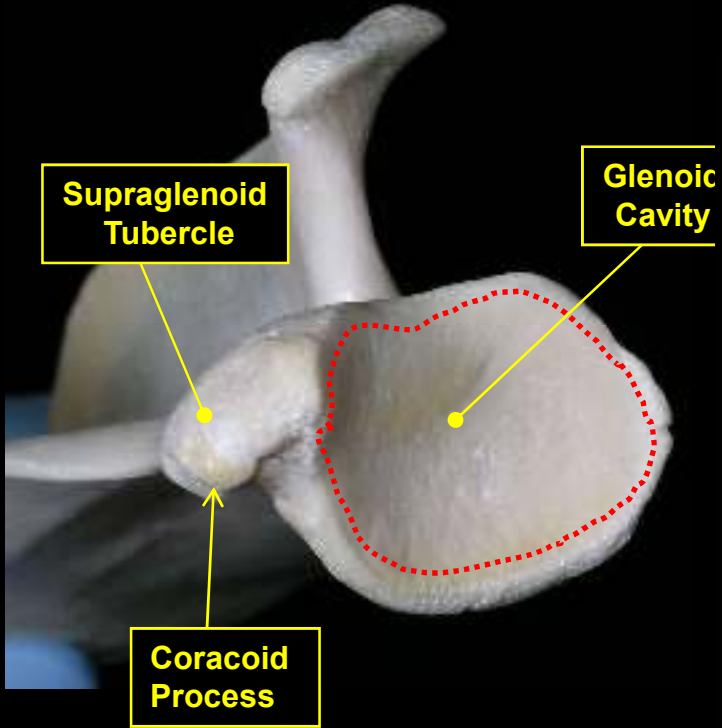
**Equine left
Scapula
Medial View**



**Infraglenoid
Tubercle**

**Canine left scapula
Medial View**

- Structures of the caudal border
 - Infraglenoid tubercle
 - » Present in the dog, but absent in the horse and cow



**Supraglenoid
Tubercle**

**Glenoid
Cavity**

**Coracoid
Process**

**Canine left
Scapula
Ventral View**



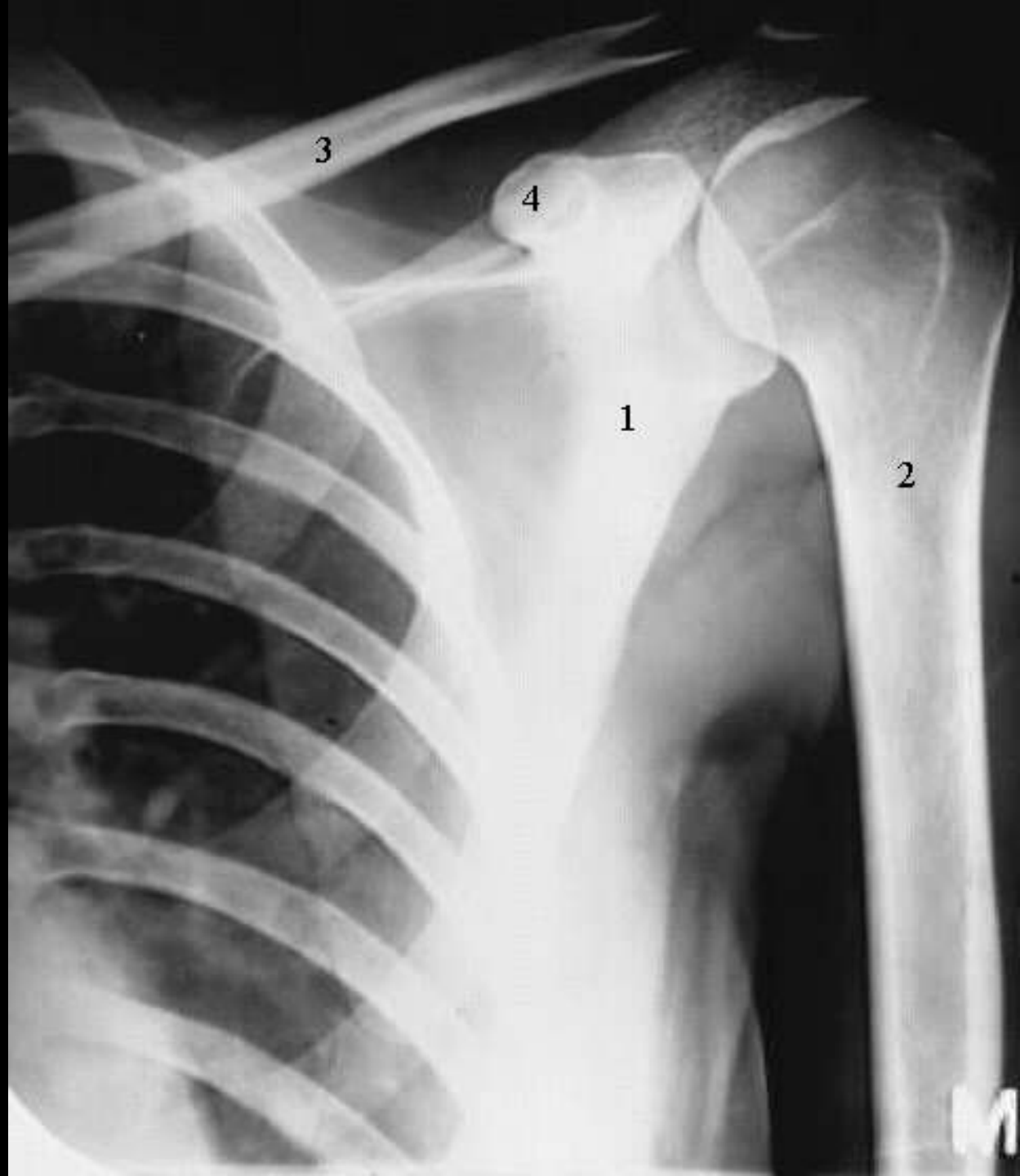
Clavoid

**Equine left scapula
Ventral view**



- Clavicle

- Functional in humans and birds (furcula)
- Present but not connected to the scapula or sternum in cats (rodlet of bone) and dogs (cartilaginous rod)
- Not present in ruminants and horses



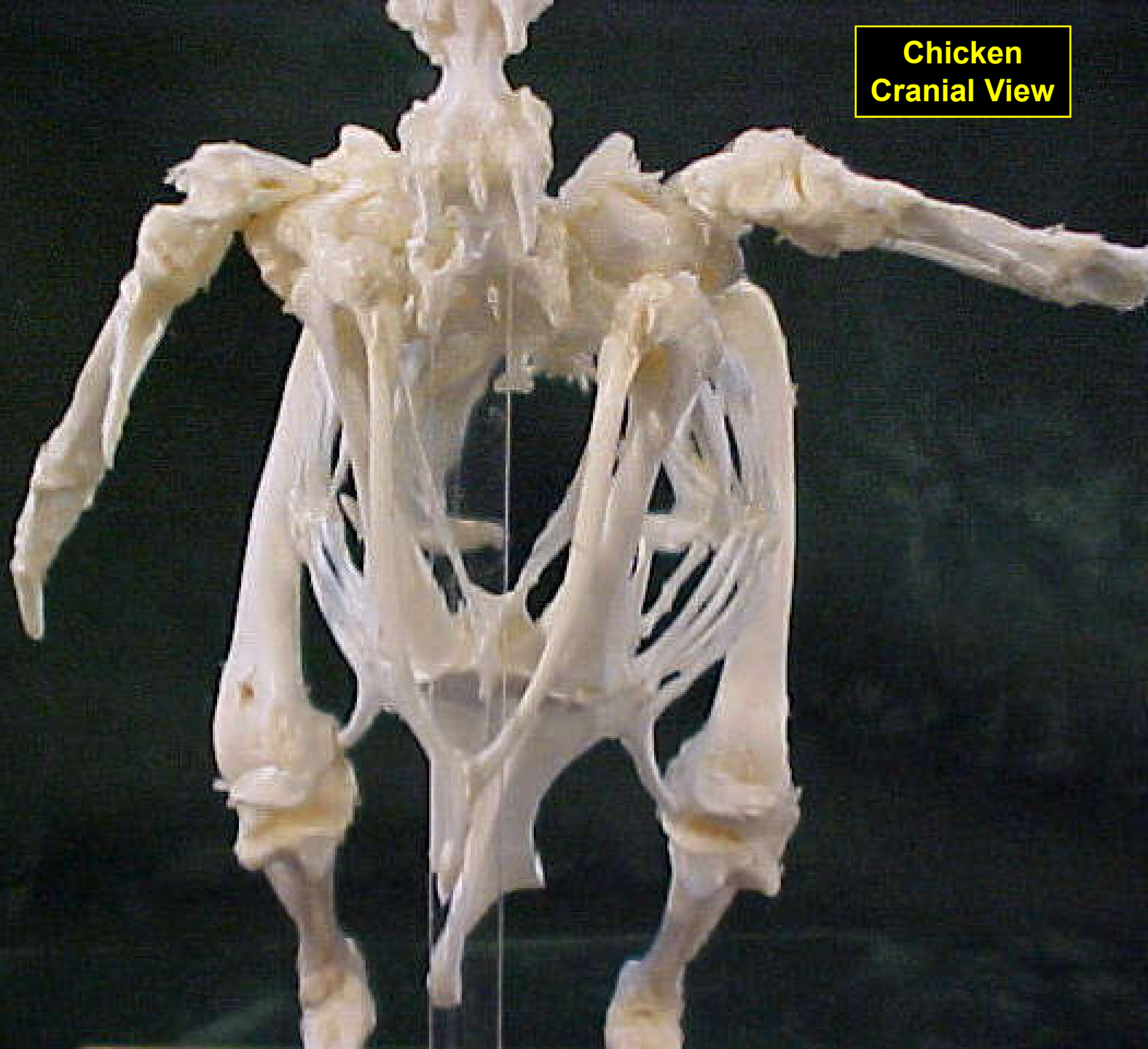
Human clavicle



Alligator femur



**Chicken
Cranial View**

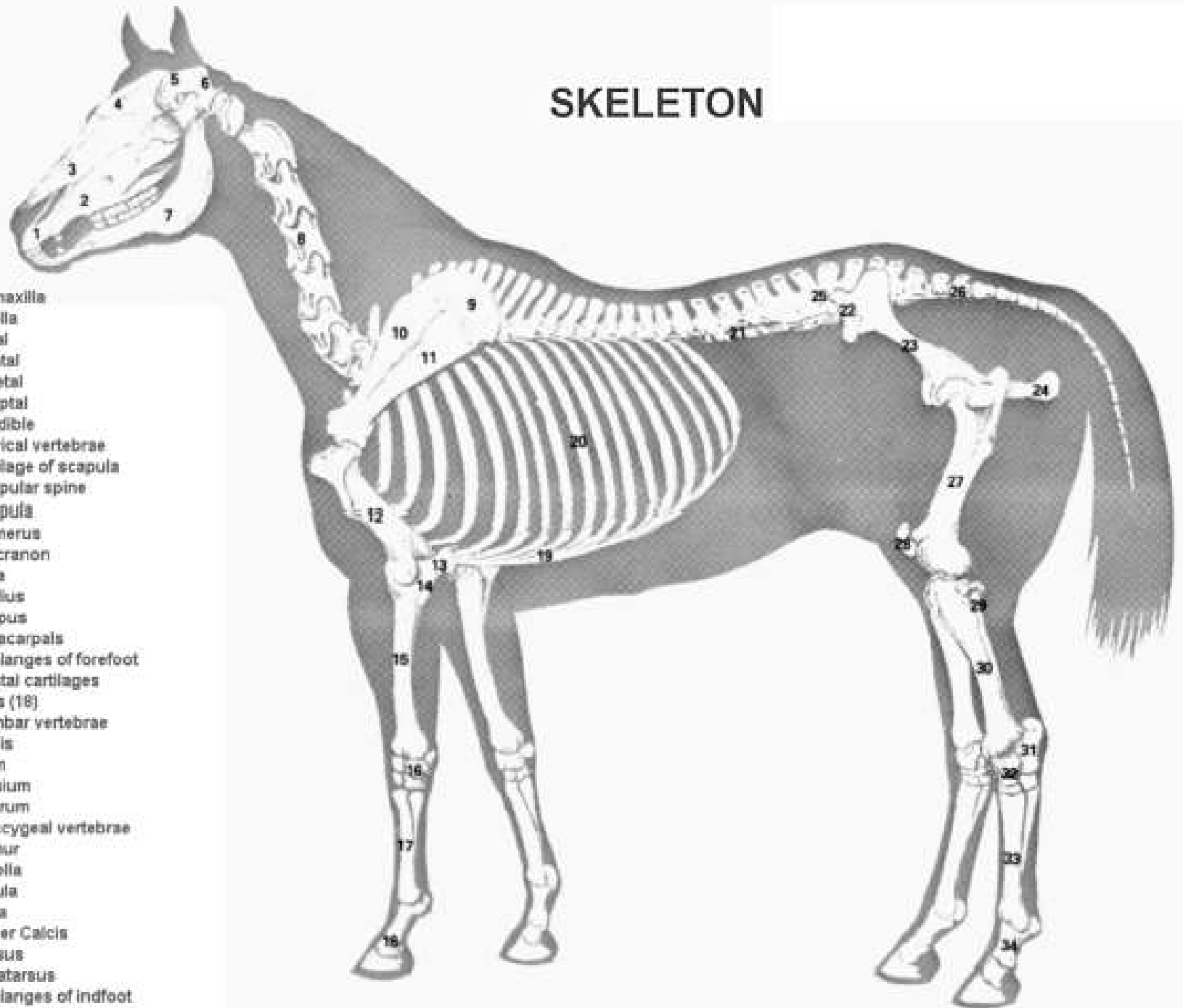


**Chicken
Lateral View**



SKELETON

1. Premaxilla
2. Maxilla
3. Nasal
4. Frontal
5. Parietal
6. Occipital
7. Mandible
8. Cervical vertebrae
9. Cartilage of scapula
10. Scapular spine
11. Scapula
12. Humerus
13. Olecranon
14. Ulna
15. Radius
16. Carpus
17. Metacarpals
18. Phalanges of forefoot
19. Costal cartilages
20. Ribs (18)
21. Lumbar vertebrae
22. pubis
23. Ilium
24. Ischium
25. Sacrum
26. Coccygeal vertebrae
27. Femur
28. Patella
29. Fibula
30. Tibia
31. Tuber Calcis
32. Tarsus
33. Metatarsus
34. Phalanges of hindfoot





De
Tubi

Greater
Tubercle

Greater
Tubercle

Deltoid
Tuberosity

Anterior view
of the left
humerus



Lateral view
of the left
humerus

- Horse
 - Greater tubercle (lateral)
 - » Divided into a cranial and caudal part
 - » Insertion for m. infraspinatus, deep tendon, (caudal part) and m. supraspinatus (cranial part)

Greater Tubercle,
Cranial Part

Intratubercular
Groove

Greater
Tubercle,
Caudal



m.
infraspinatus,
deep tendon

view

view



Lesser Tubercle

Lesser Tubercle,
Cranial Part

- Horse
 - Lesser tubercle (medial)
 - » Composed of a cranial and a caudal part
 - » Insertion for m. supraspinatus (cranial) and m. subscapularis (caudal)

Lesser Tubercle,

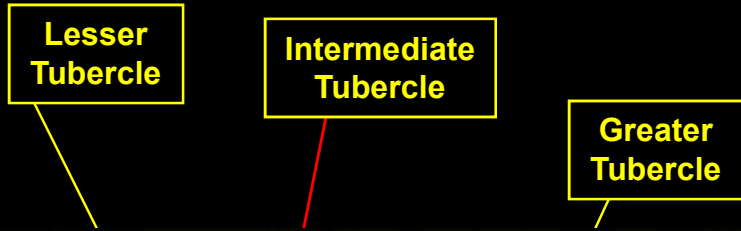
ft
s
w

:
w

- Horse

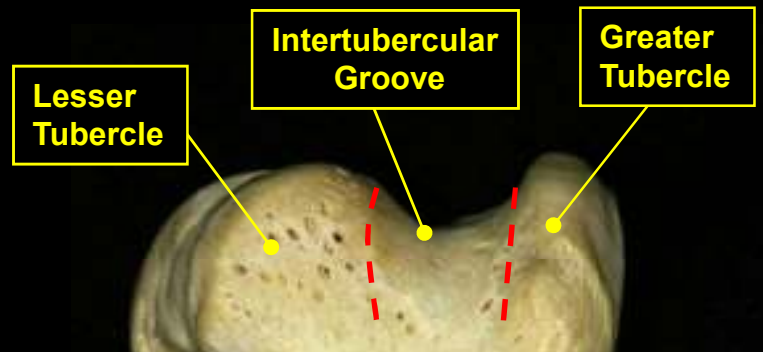
- Intertubercular groove

- » Located on the cranial articular surface between the greater and lesser tubercles
 - » M. biceps brachii passes through the intertubercular groove
 - » Divided by an intermediate tubercle



Intertubercular Groove

Canine humerus
Cranial View



Canine left humerus
Craniomedial Oblique View

**Bovine
Left humerus
Cranial View**



**Equine
Left humerus
Cranial View**



Canine

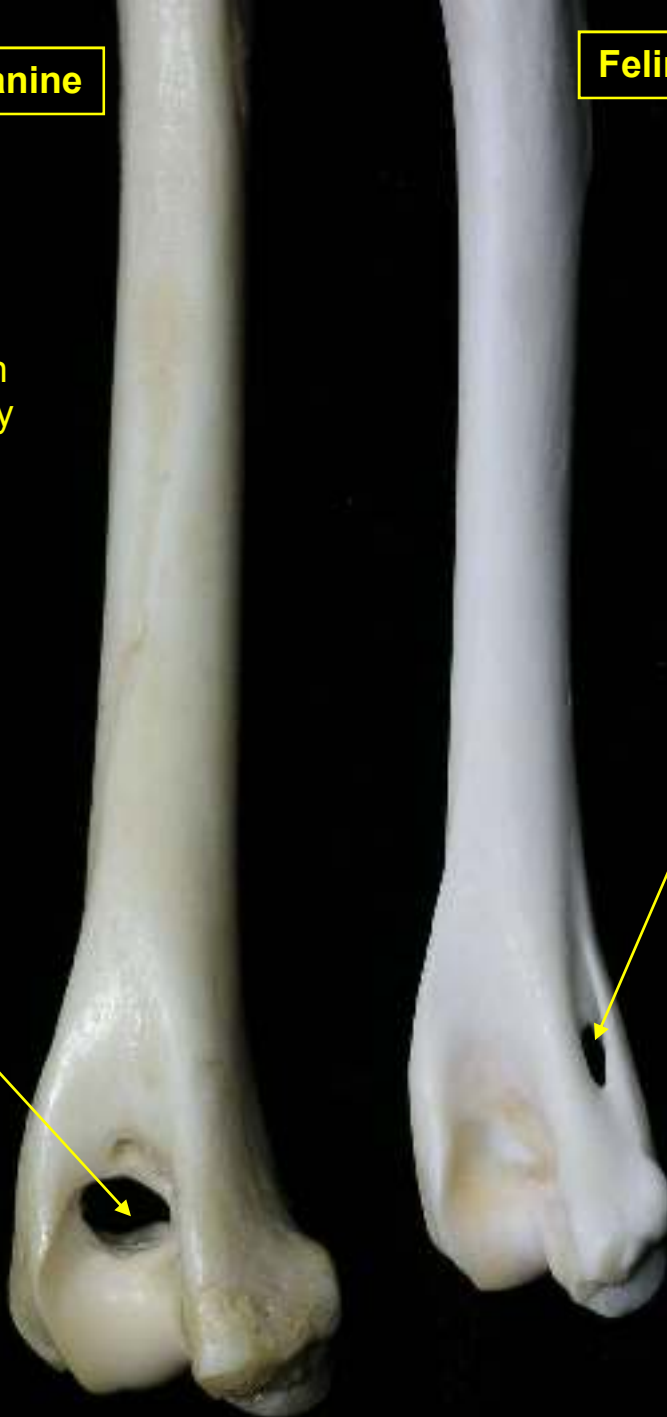
Feline

**Canine and
Feline
Left Humeri
Caudal View**

–Supracondylar foramen in the cat through which the median nerve and brachial artery pass

**Supratrochlear
Foramen**

**Supracondylar
Foramen**





**Canine left
Radius and ulna
Caudal view**



**Bovine left
Radius and ulna
Caudal view**



Radius and Ulna

- The radius and ulna cross in the dog
- Fused in the horse and ruminant (permanently pronated)

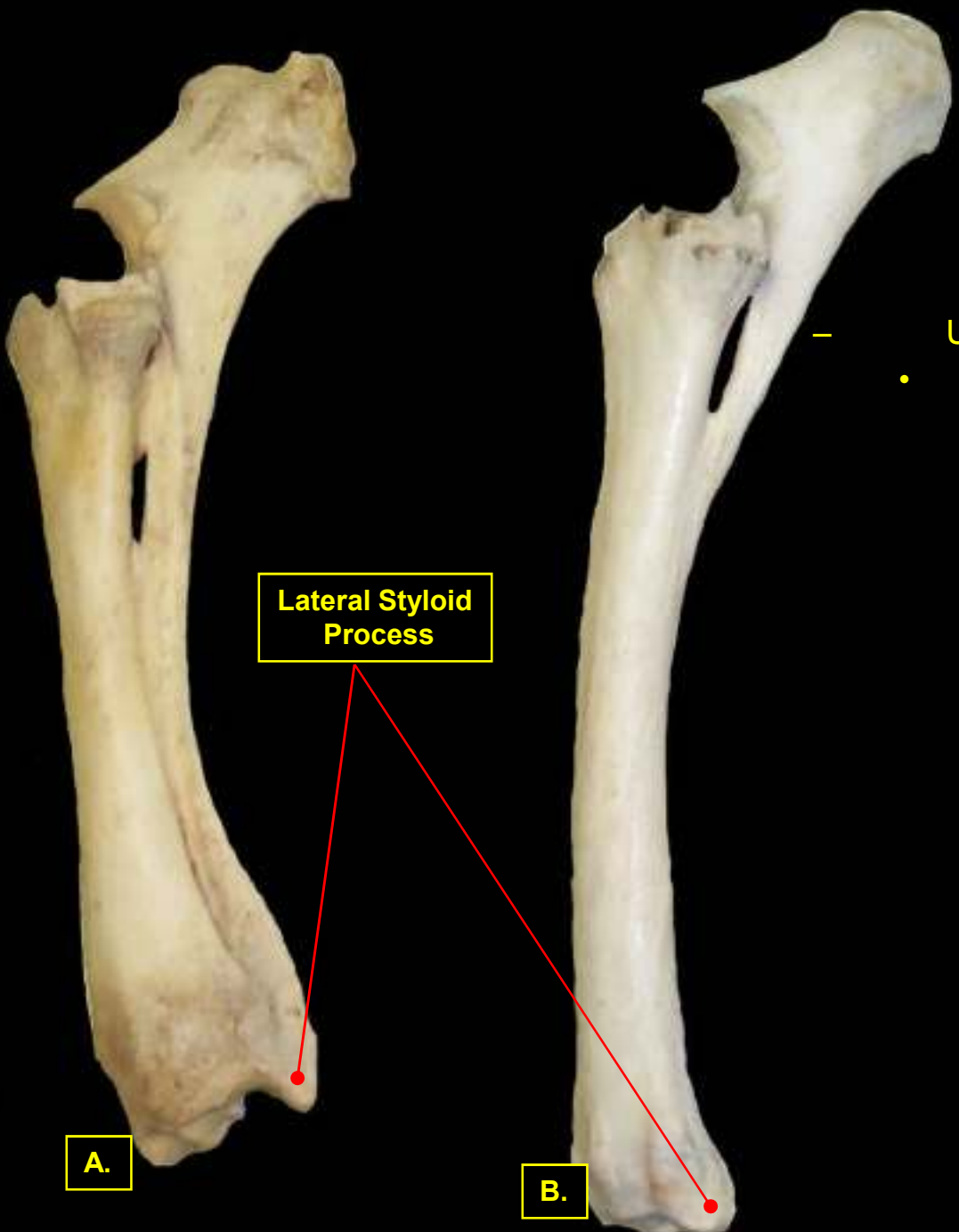
**Bovine left
Radius/ulna
Lateral View**



**Equine left
Radius/ulna
Lateral View**



**Bovine (A) and Equine (B)
Left radius and ulna in
Lateral view**



**Lateral Styloid
Process**

A.

B.

Ulna

- Lateral styloid process (ulna)
 - The distal ulna is fused with radius in the horse so the lateral styloid process is actually formed by the ulna

Equine left radius



**Lateral Styloid
Process**

- **Carpal Bones**

- The accessory carpal articulates with the caudal surface of the ulnar carpal only in the cow, and with both the ulnar carpal and the distal end of the ulna in the horse and dog
- There are four distal carpal bones present in the dog (1-4), three in the horse (2-4), and two in the cow [2+3 (fused) and 4]

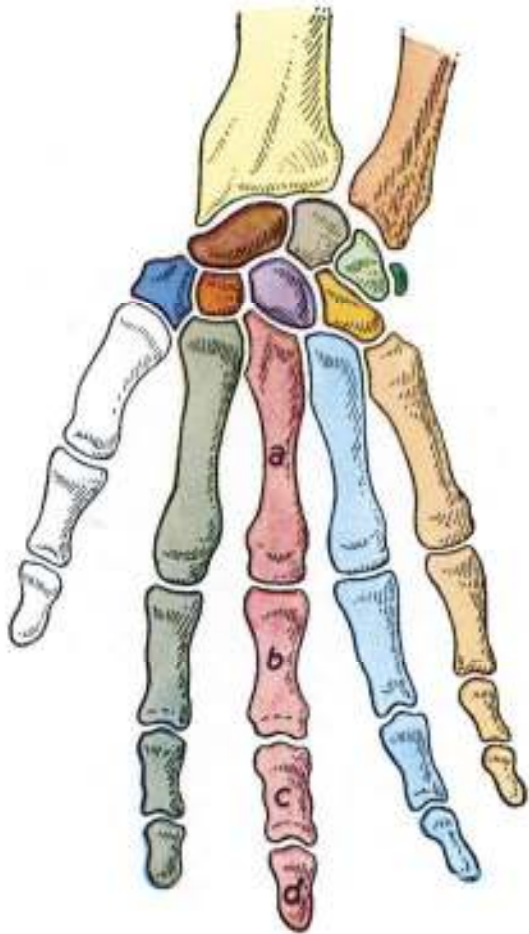


Fig. 116 (man)

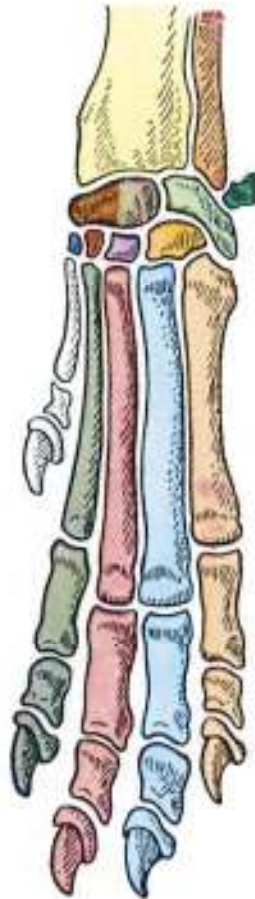


Fig. 117 (dog)



Fig. 118 (pig)

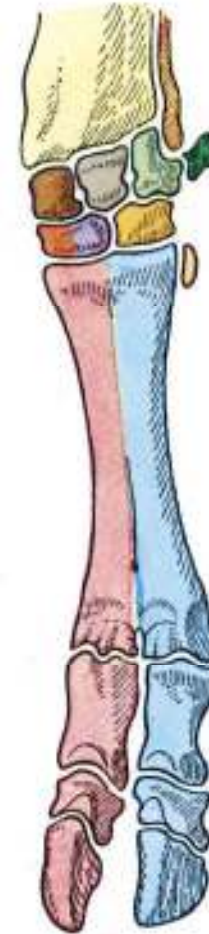


Fig. 119 (ox)

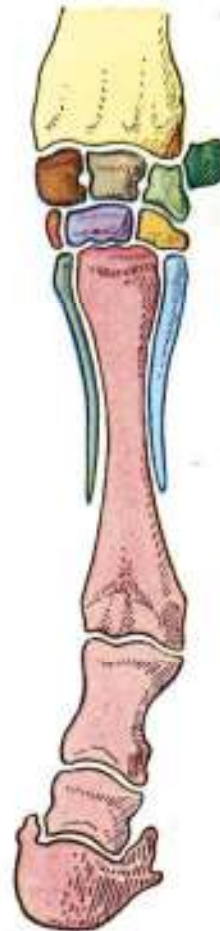


Fig. 120 (horse)

**Radial
Carpal**

**Accessory
Carpal**

**Ulnar
Carpal**

**Intermediate
Carpal**

2

3

4

**Equine left
Carpus
Dorsal view**



**Accessory
Carpal**

**Intermediate
Carpal**

**Ulnar
Carpal**

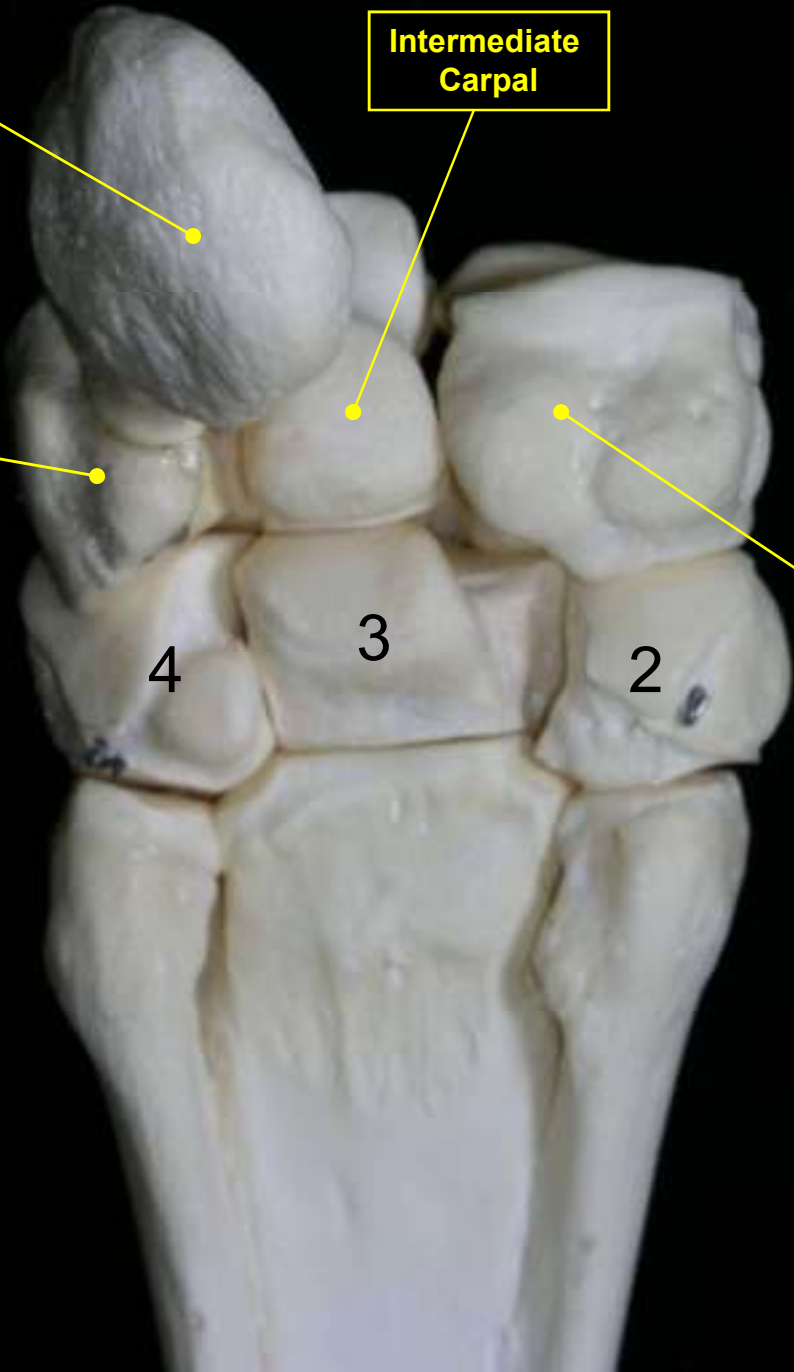
**Radial
Carpal**

4

3

2

**Equine left
Carpus
Palmar view**



**Radial
Carpal**

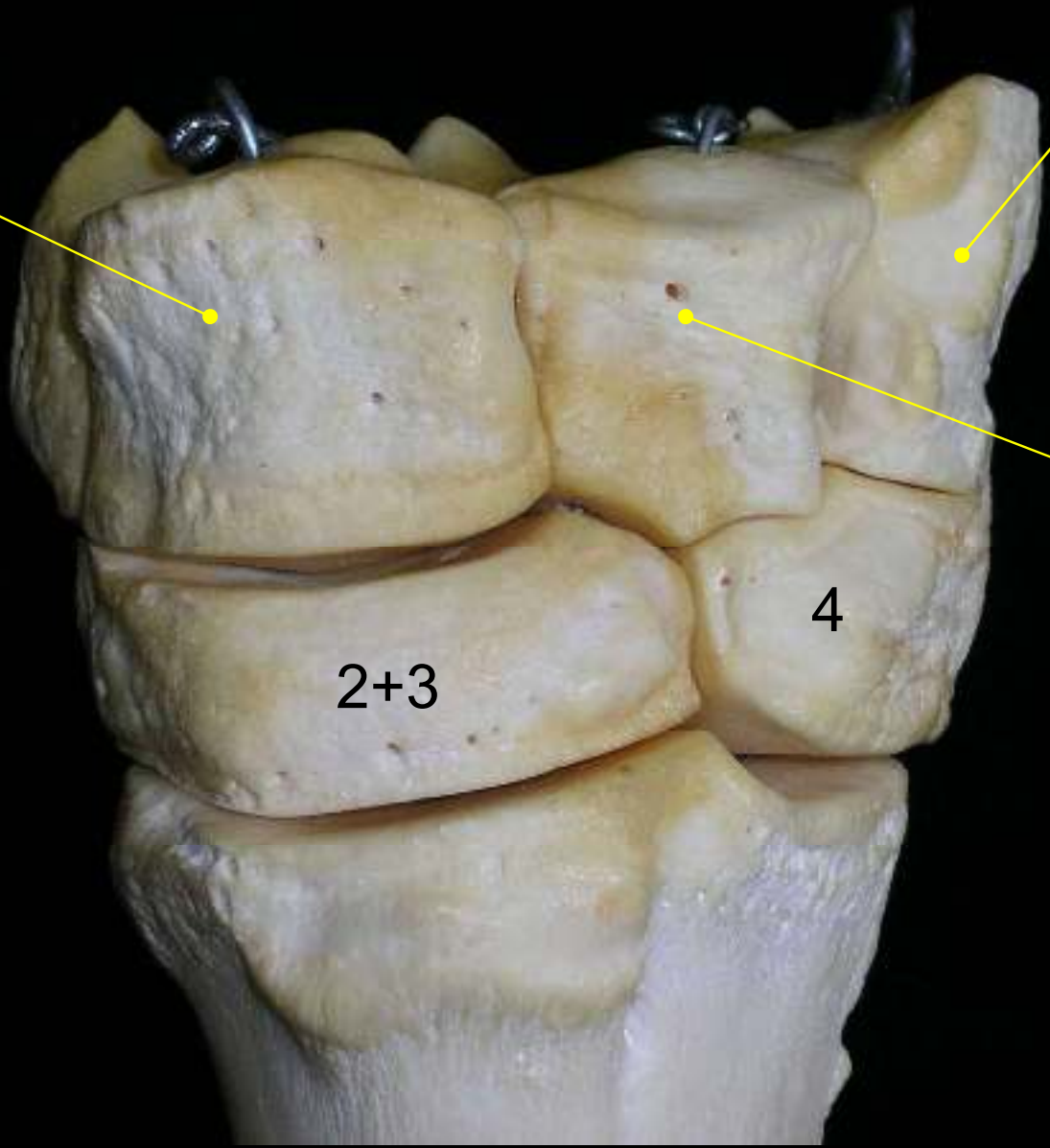
**Ulnar
Carpal**

**Intermediate
Carpal**

2+3

4

**Bovine left
Carpus
Dorsal view**



**Accessory
Carpal**

**Intermediate
Carpal**

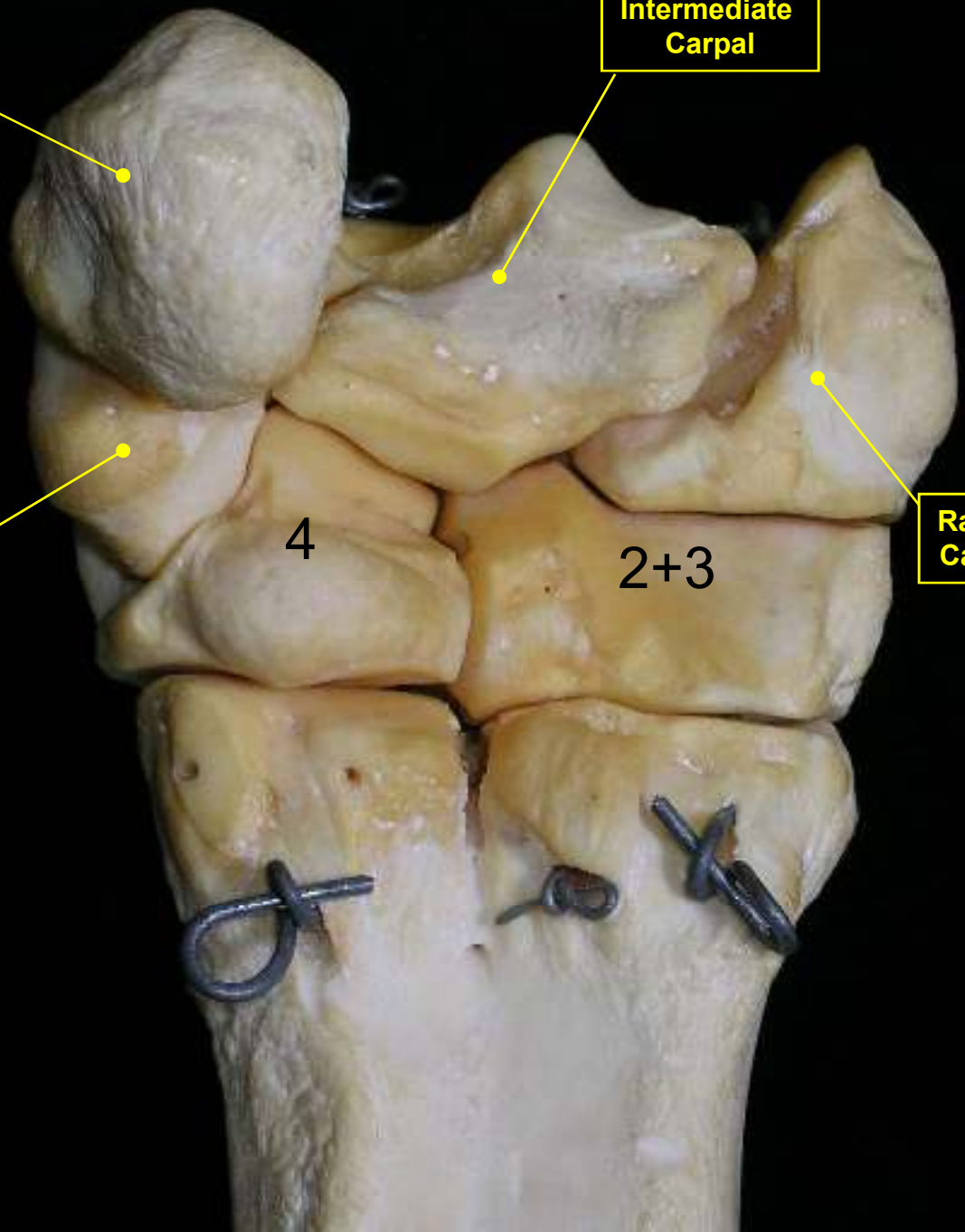
**Ulnar
Carpal**

**Radial
Carpal**

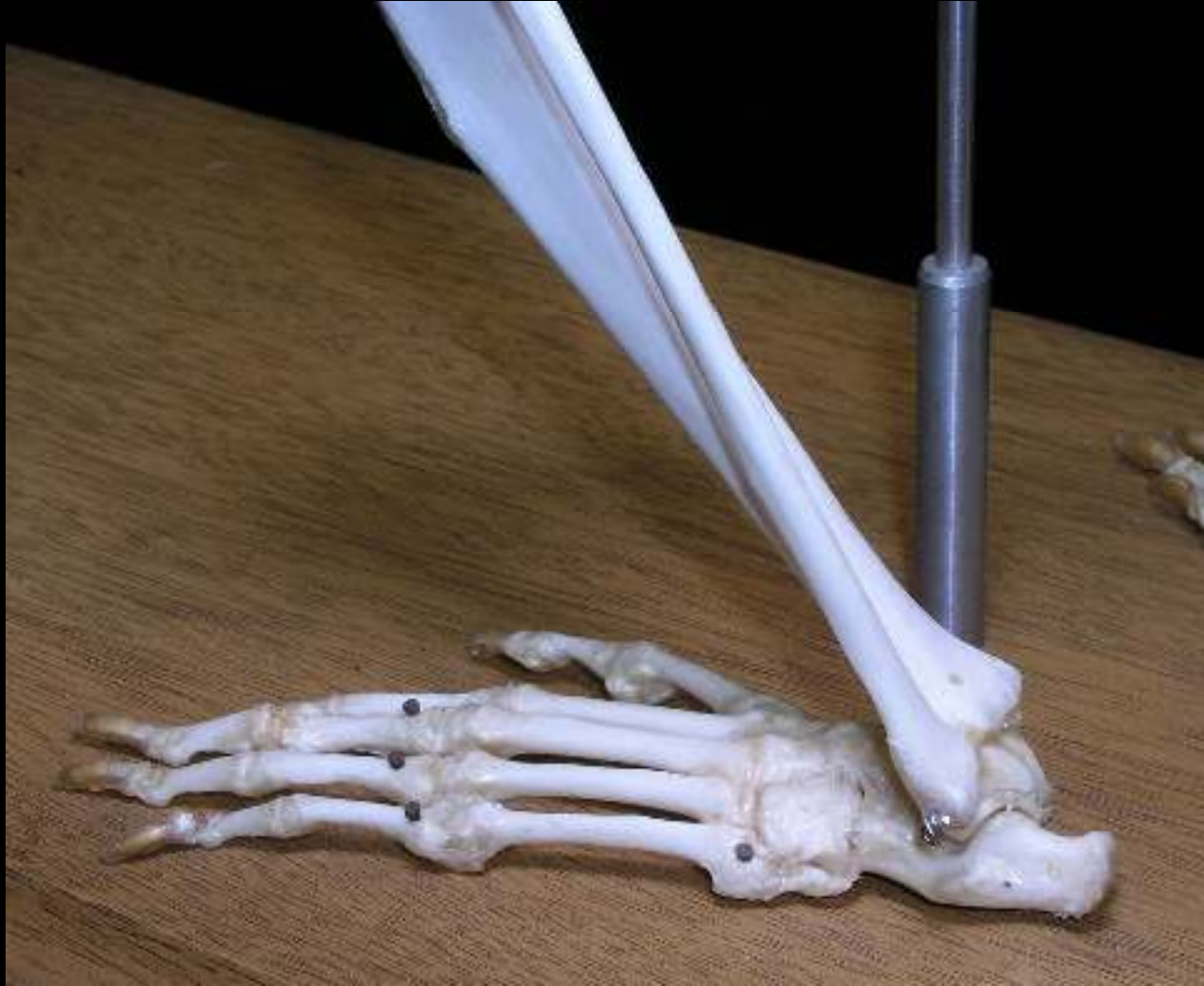
4

2+3

**Bovine left
Carpus
Palmar view**



- Posture
 - Plantigrade – carpal bones (tarsal bones) in contact with the ground and entire carpus (tarsus) is used for support
 - Examples: Armadillo, Bear, Man, Alligator



**Primate left
Hindlimb
Lateral view**

**Canine left
Forelimb
Lateral view**



- Posture
 - Digitigrade – digits only are used for support
 - Examples: Cats, Dogs, Birds

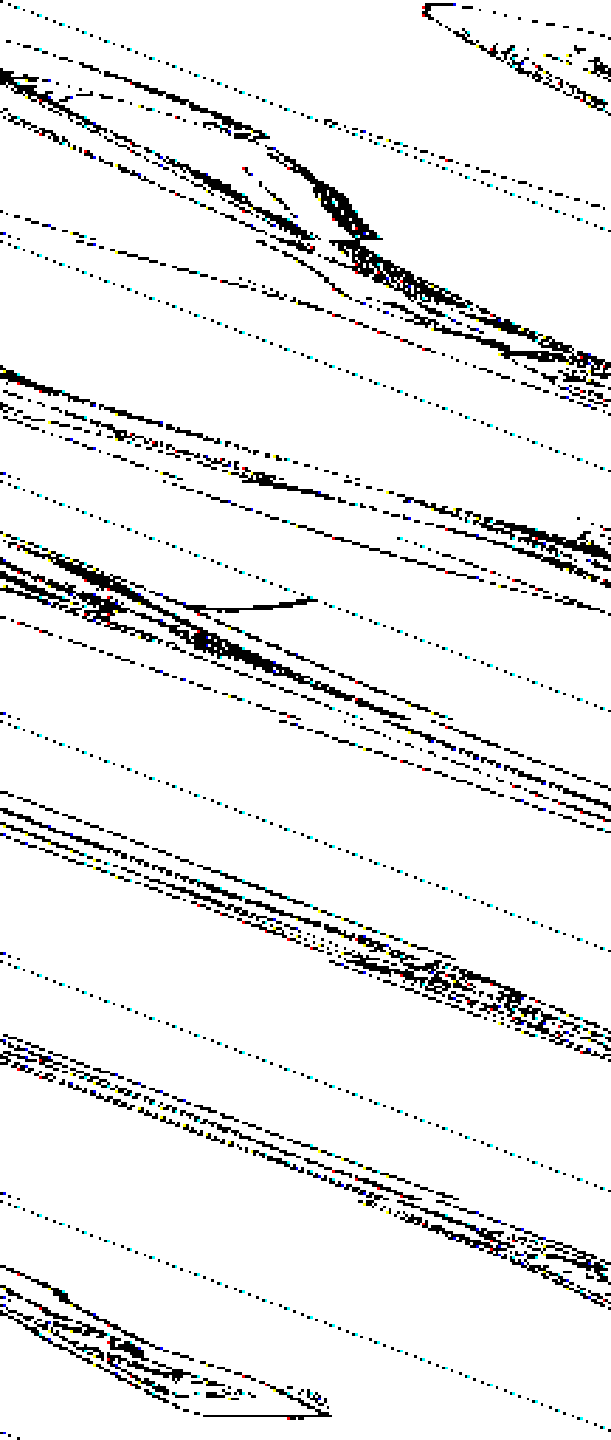
- Posture
 - Unguligrade – only the terminal phalanges (protected by hooves) give support
 - Examples: Cow, Horse, Pig
 - Plantigrade posture is found in slower species; whereas, unguligrade posture is an adaptation for speed



**Bovine left
Thoracic limb
Lateral view**



**Equine left
Thoracic limb
Lateral view**

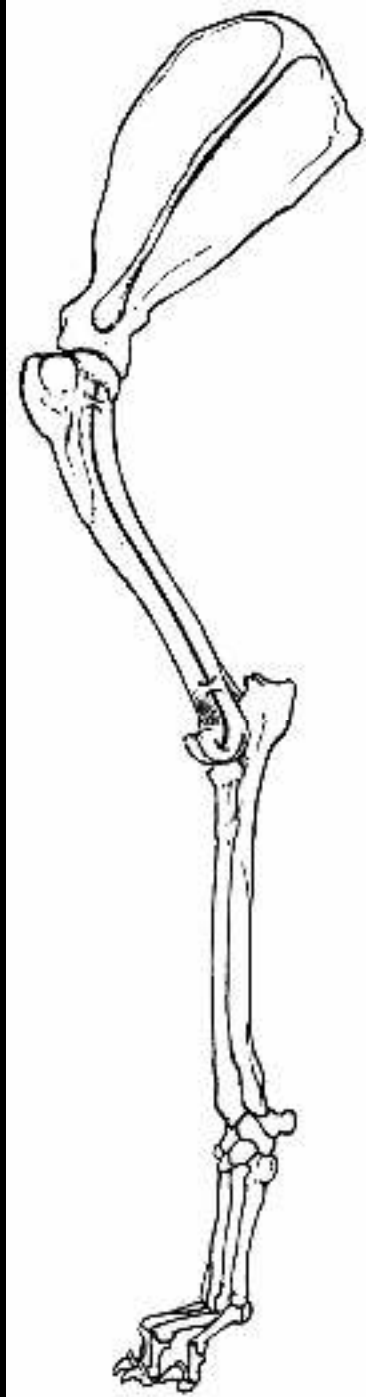


**Equine left
Thoracic limb
Lateral View**

Unguligrade

**Canine left
Thoracic limb
Lateral View**

Digitigrade



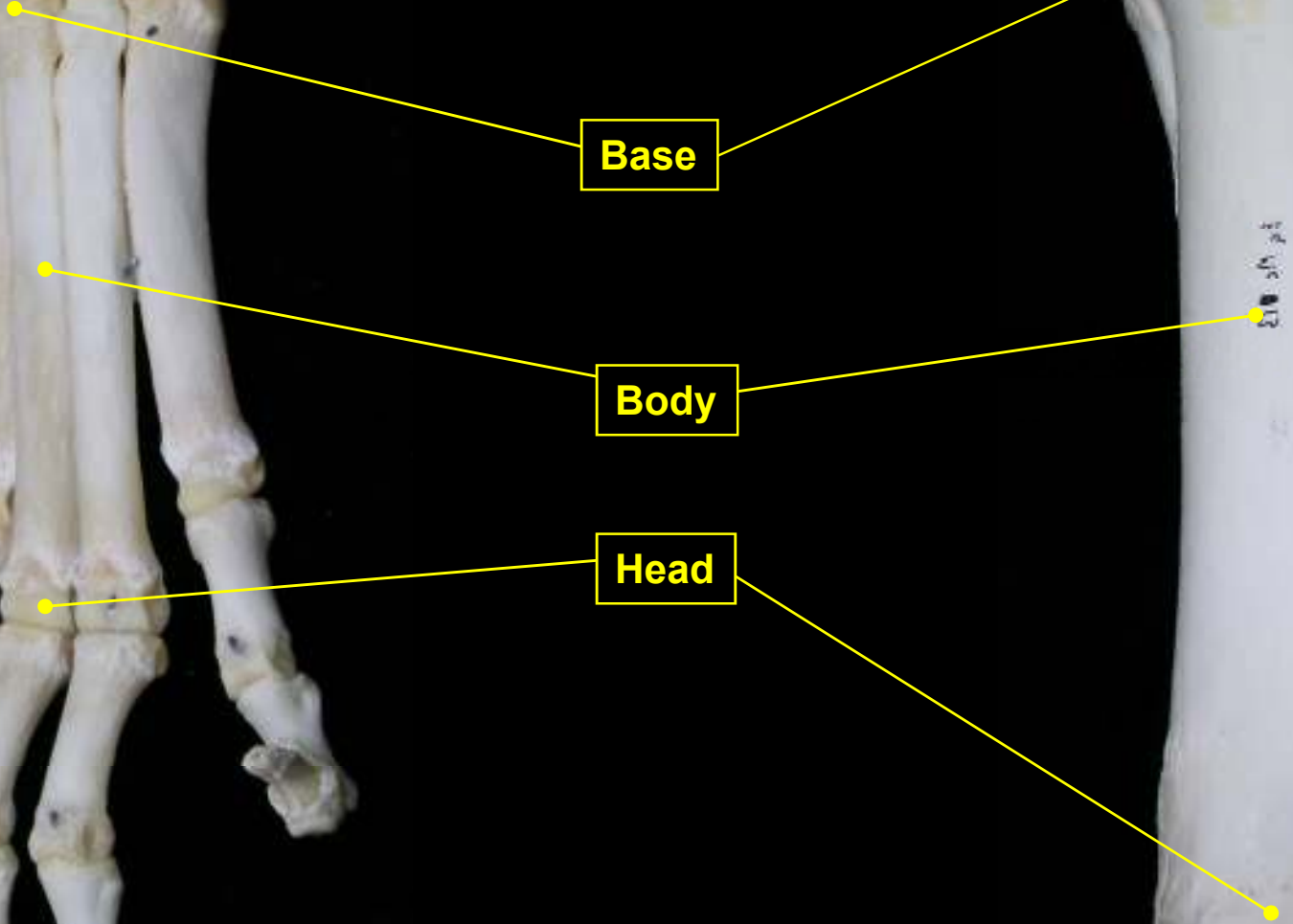
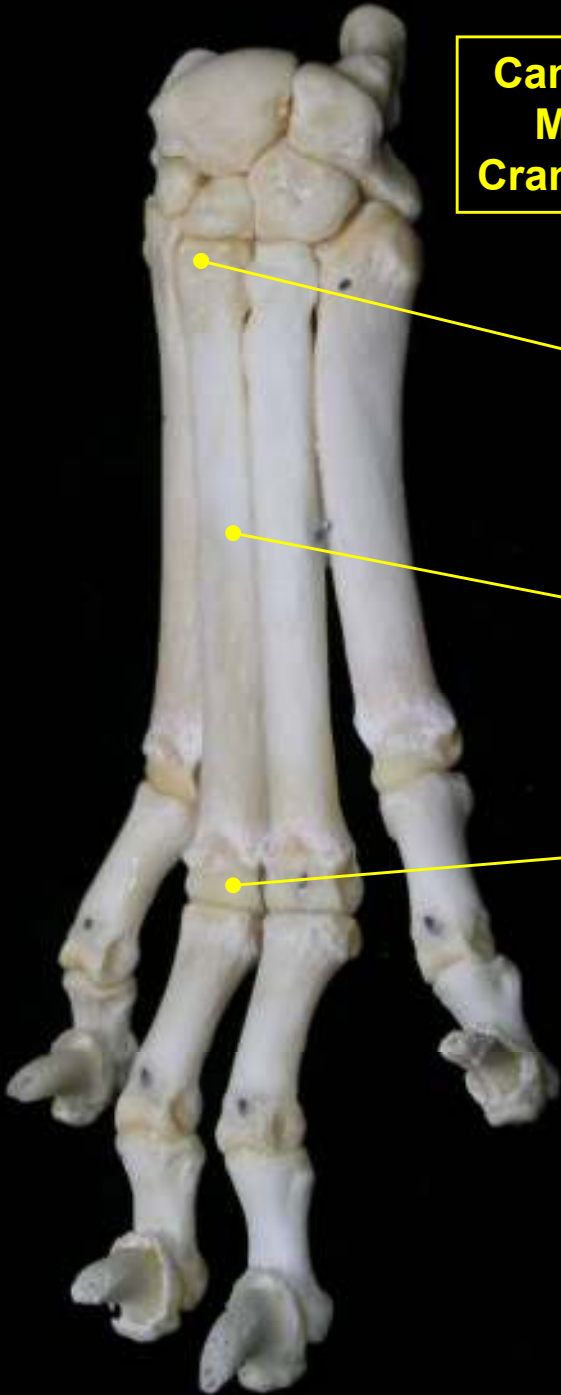
**Canine left
Manus
Cranial view**

**Equine left
Metacarpus
Cranial view**

Base

Body

Head

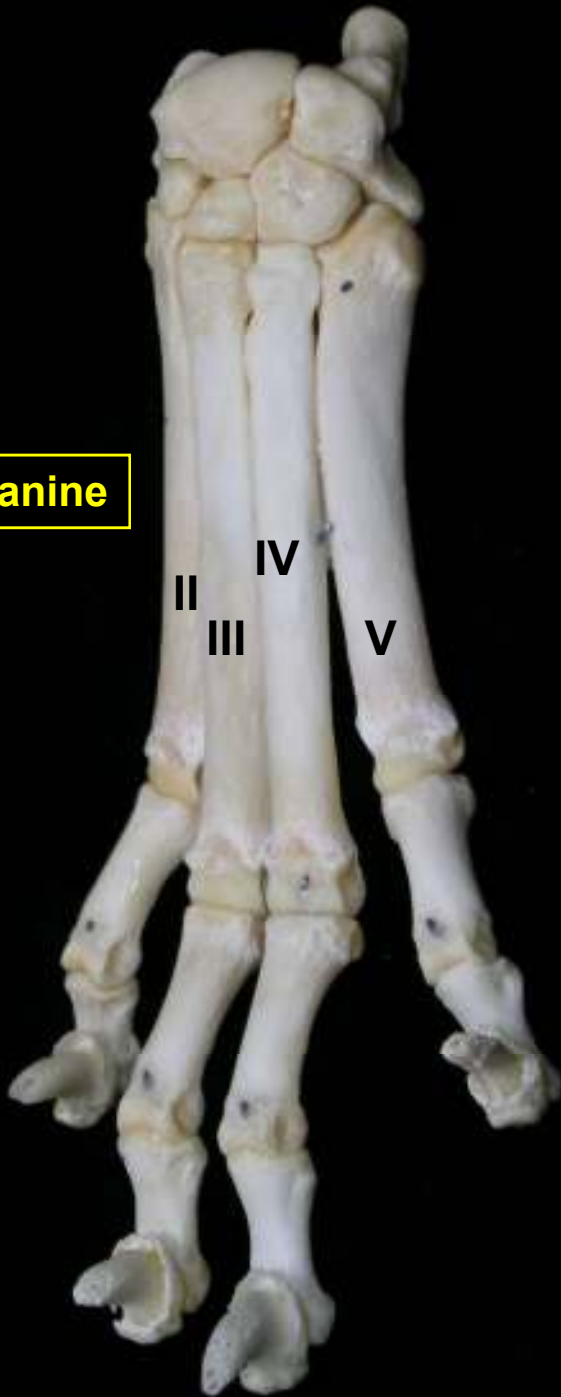


- **Metacarpals**

- The number of metacarpal bones varies between species

- The dog has five metacarpals, but only four are functional (contact the ground)
 - The cow has two functional fused metacarpals (III and IV) as well as a vestigial fifth metacarpal
 - The horse has a single functional metacarpal (III) as well as two abaxial metacarpals (II and IV), the splint bones, which do not contact the ground

Canine



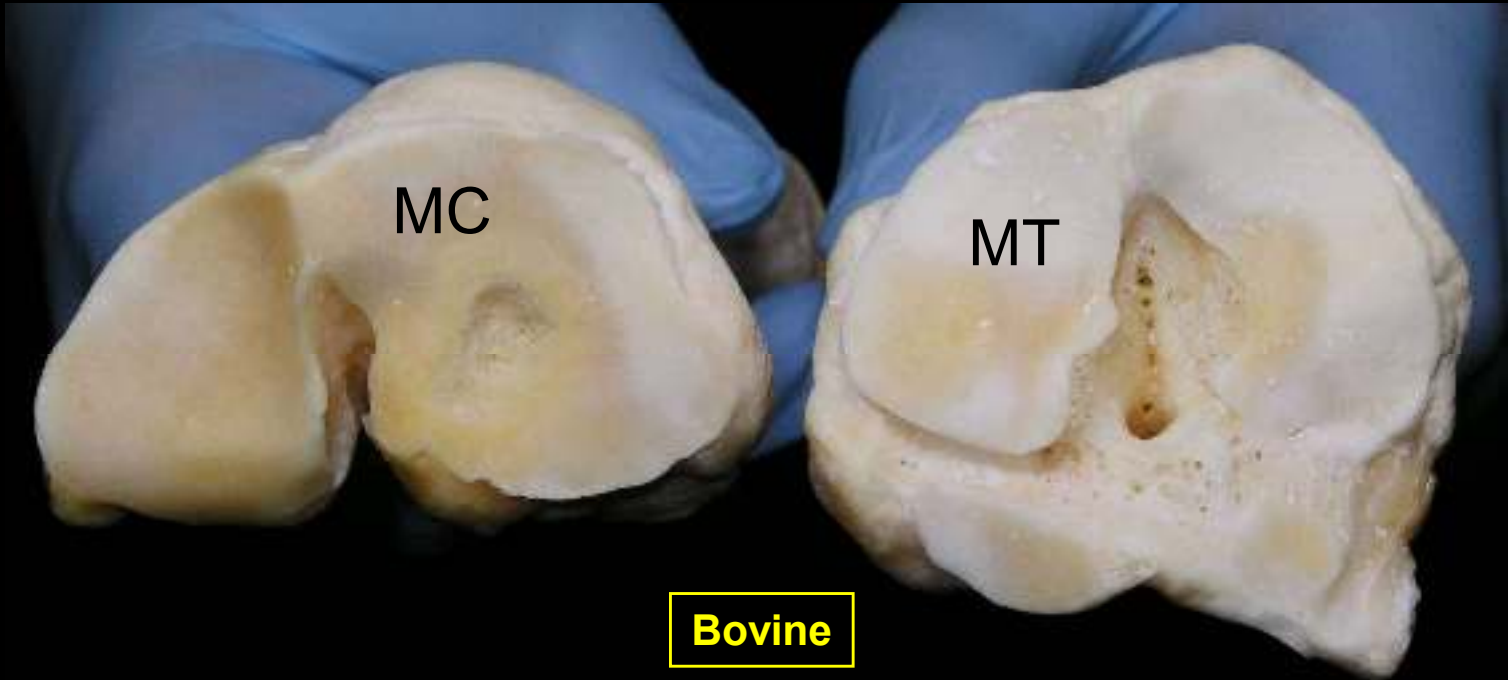
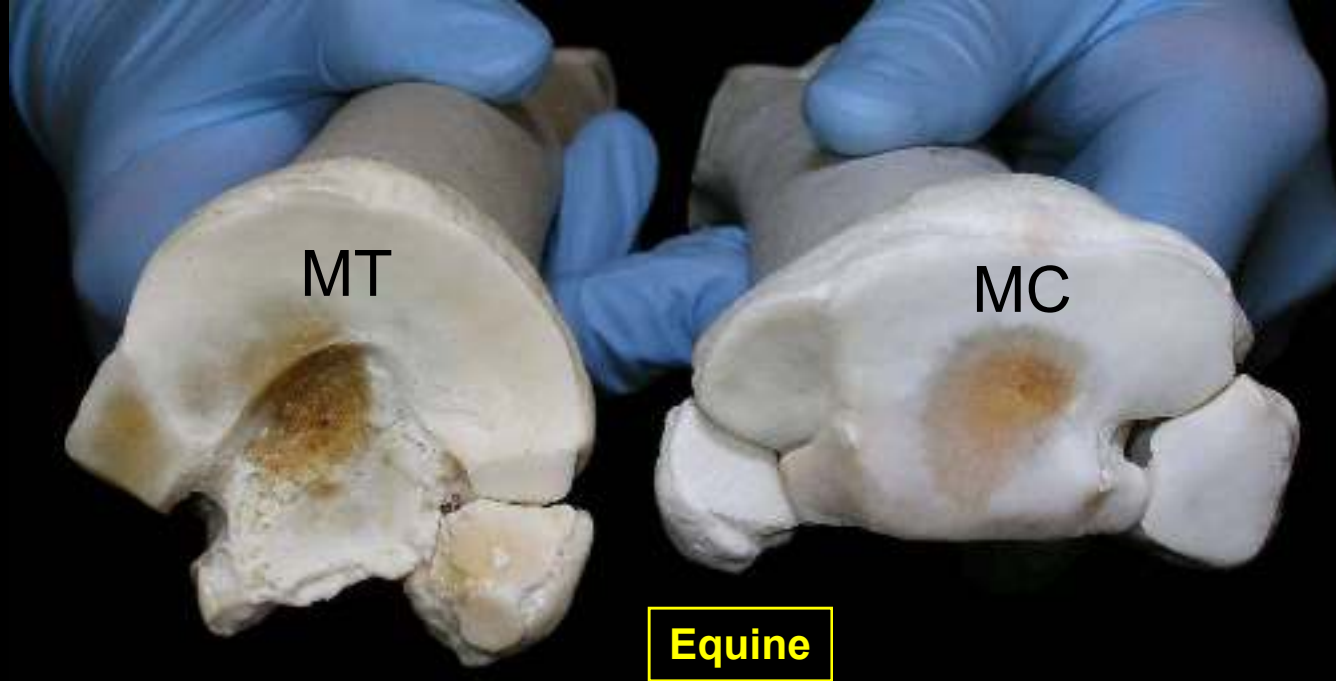
Bovine



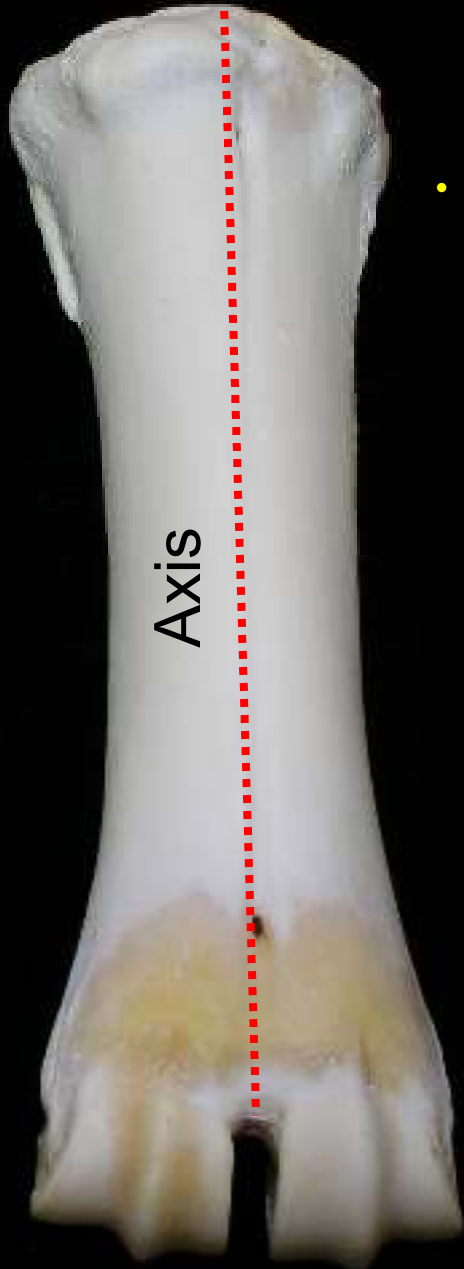
Equine



Proximal Views



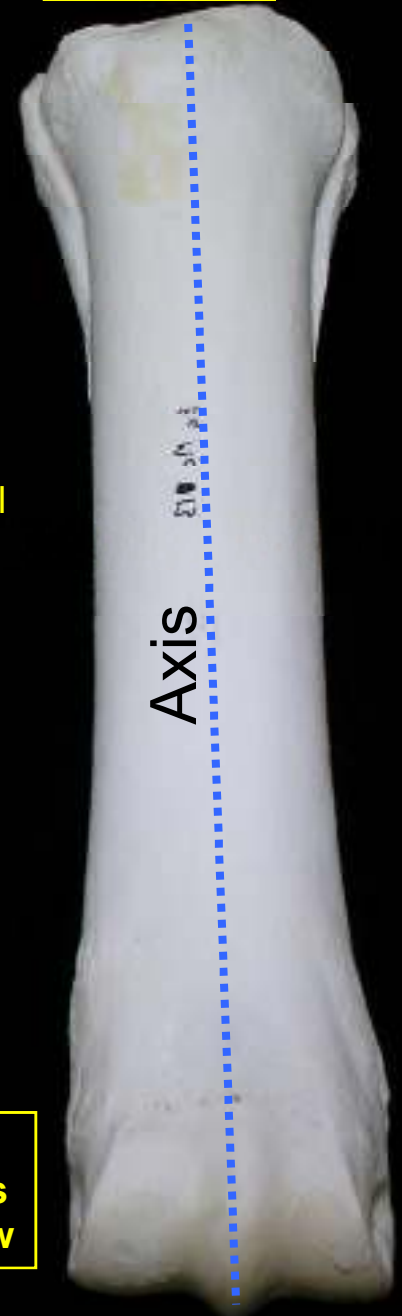
Paraxonix



**Ruminant
Metacarpus
Dorsal view**

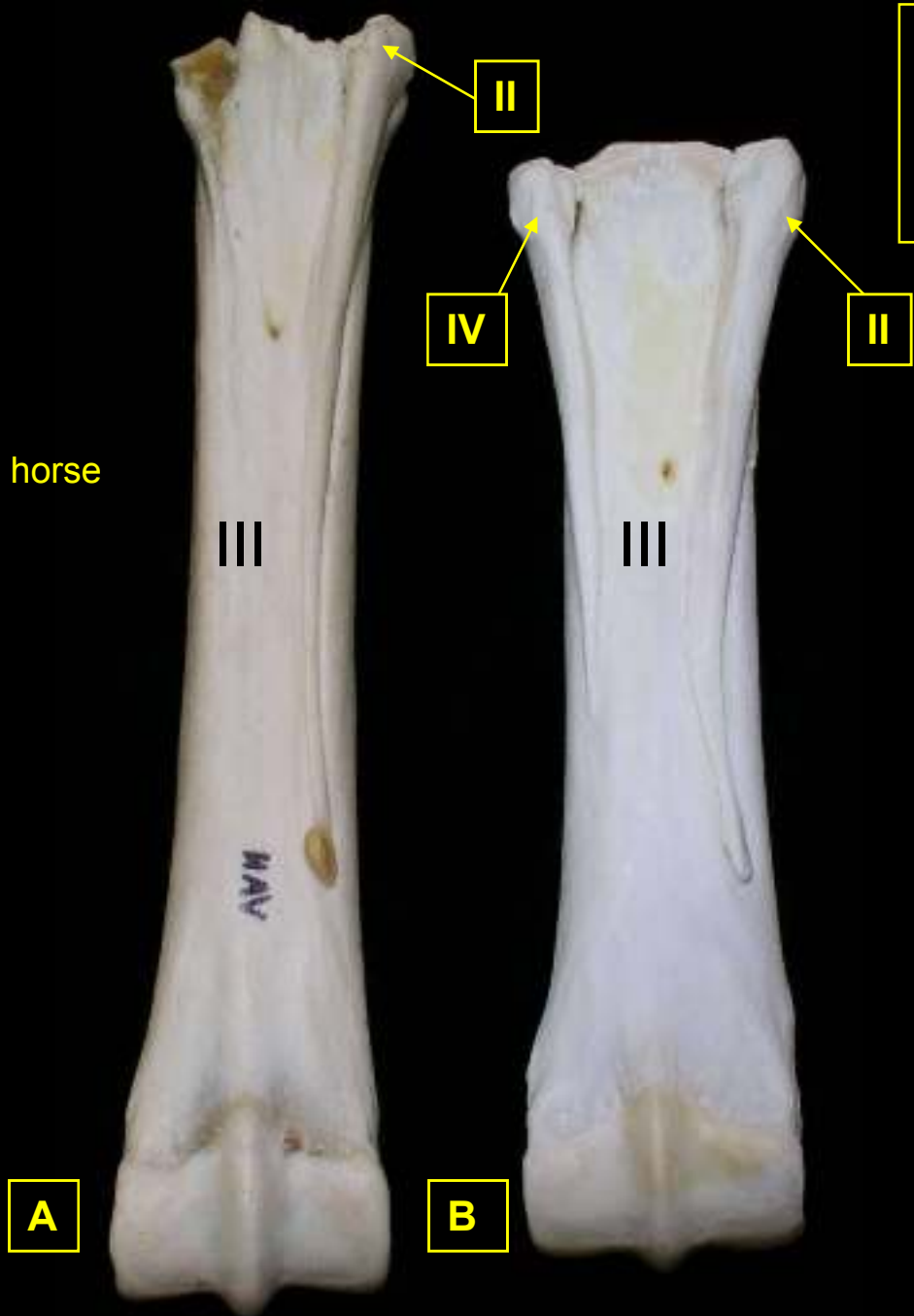
- Metacarpal symmetry
 - Paraxonic symmetry – axis of the functional manus passes between the third and fourth digits
 - Examples: dog, pig, cow
 - Mesaxonic symmetry – axis of the functional manus passes through the third digit
 - Example: horse, human

Mesaxonic



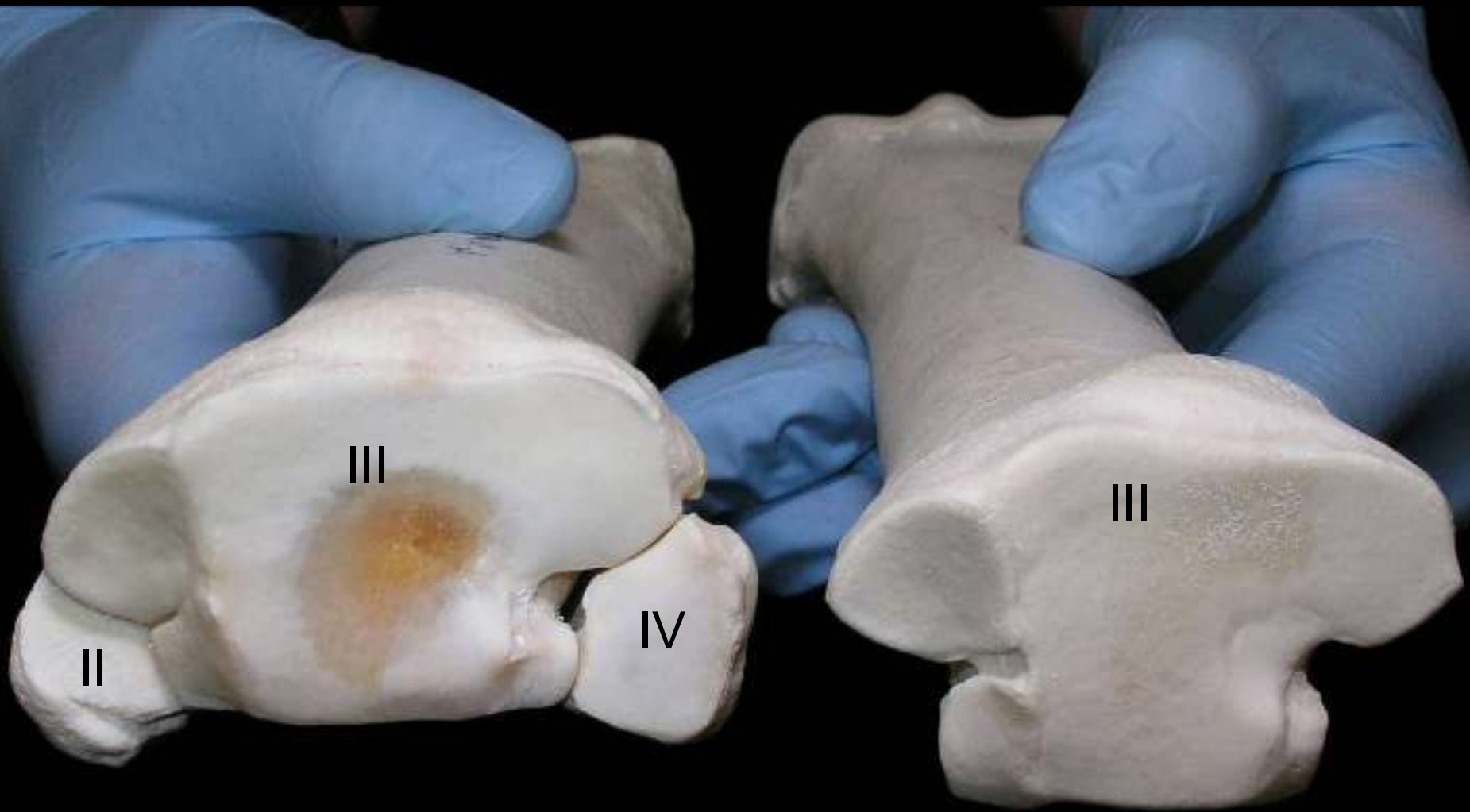
**Equine
Metacarpus
Dorsal view**

Equine left
Metatarsus (A)
And
Metacarpus (B)
Palmar Views



- The medial splint bone in the horse is usually the longest

- One or both of the splint bones may be fused with the single functional metacarpal

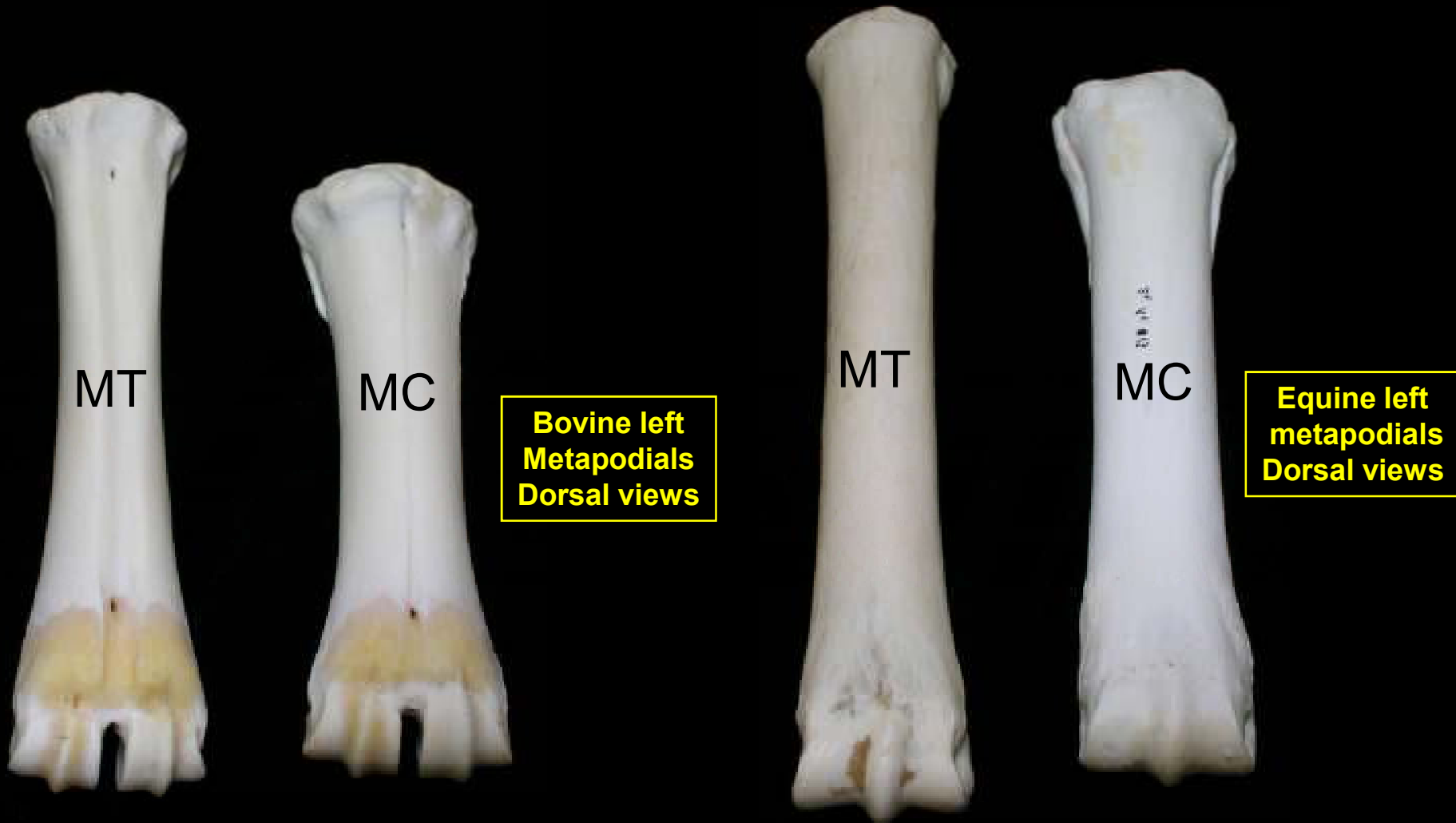


**Equine left
Metacarpals
Proximal Views**

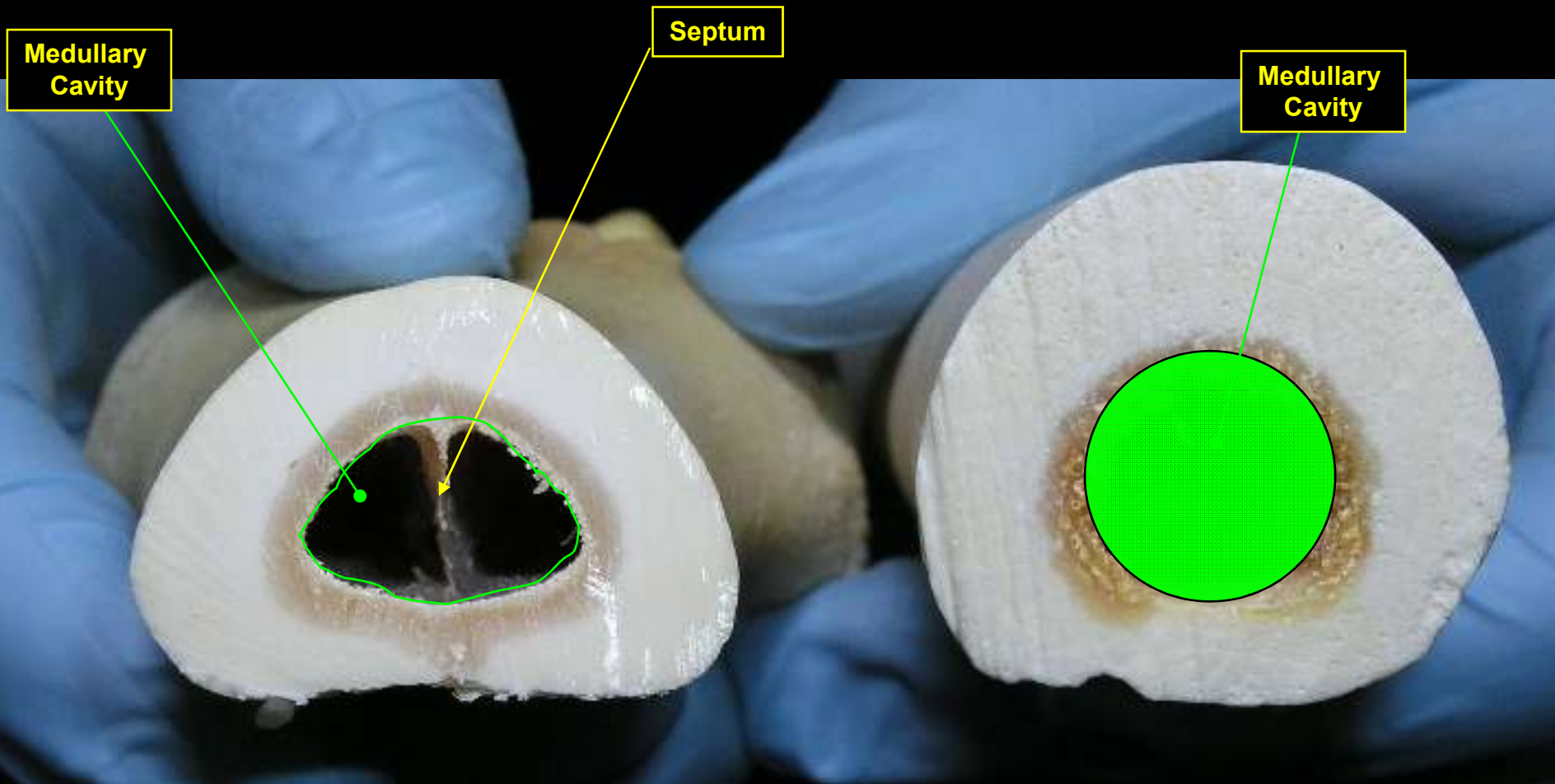


**SPLINT
BONES**

- Metacarpals cont.
 - The fused metacarpals (MC) (and metatarsals (MT)) found in ruminants and the single functional metacarpal (and metatarsal) of the horse are referred to as the cannon bone



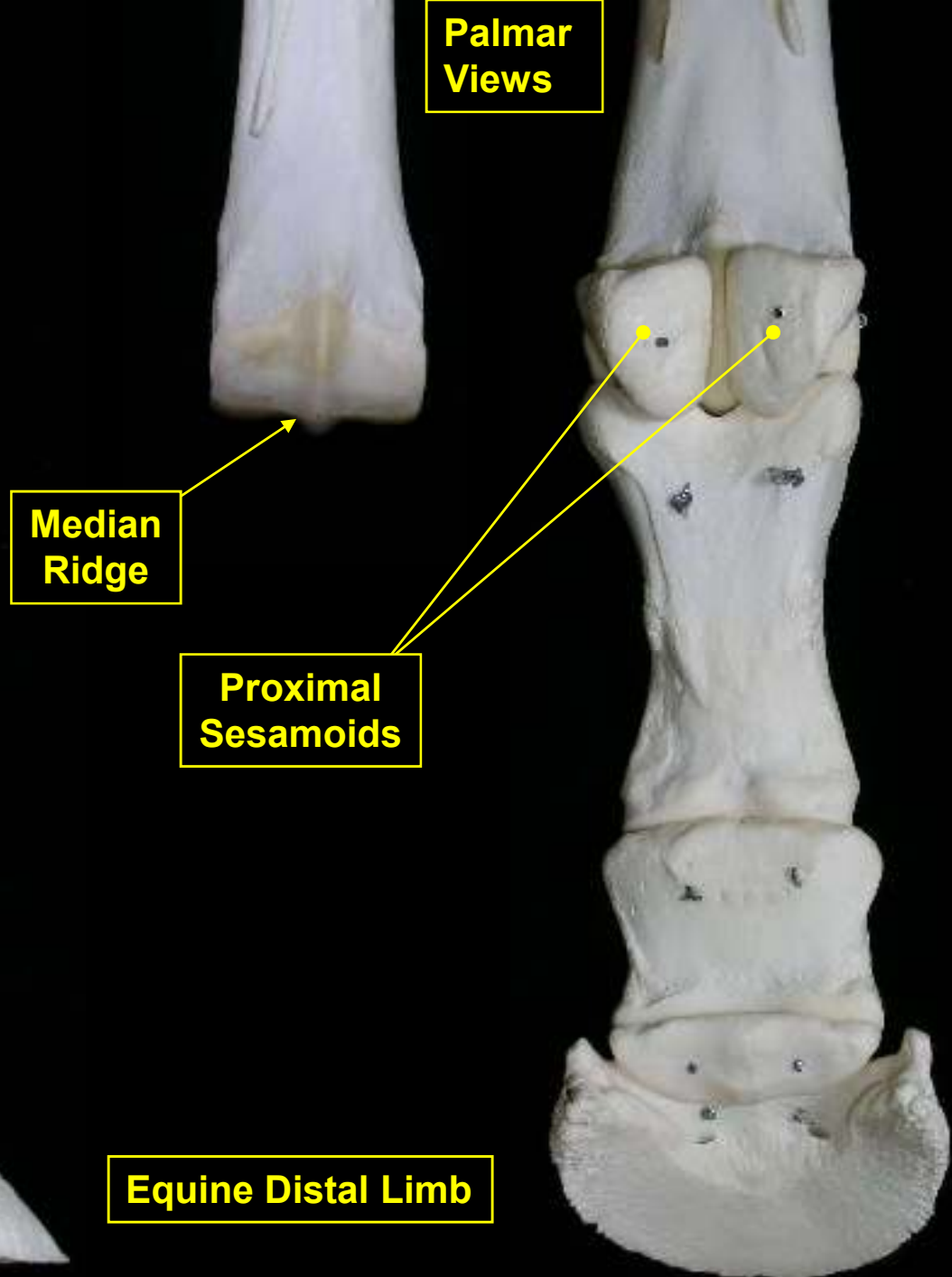
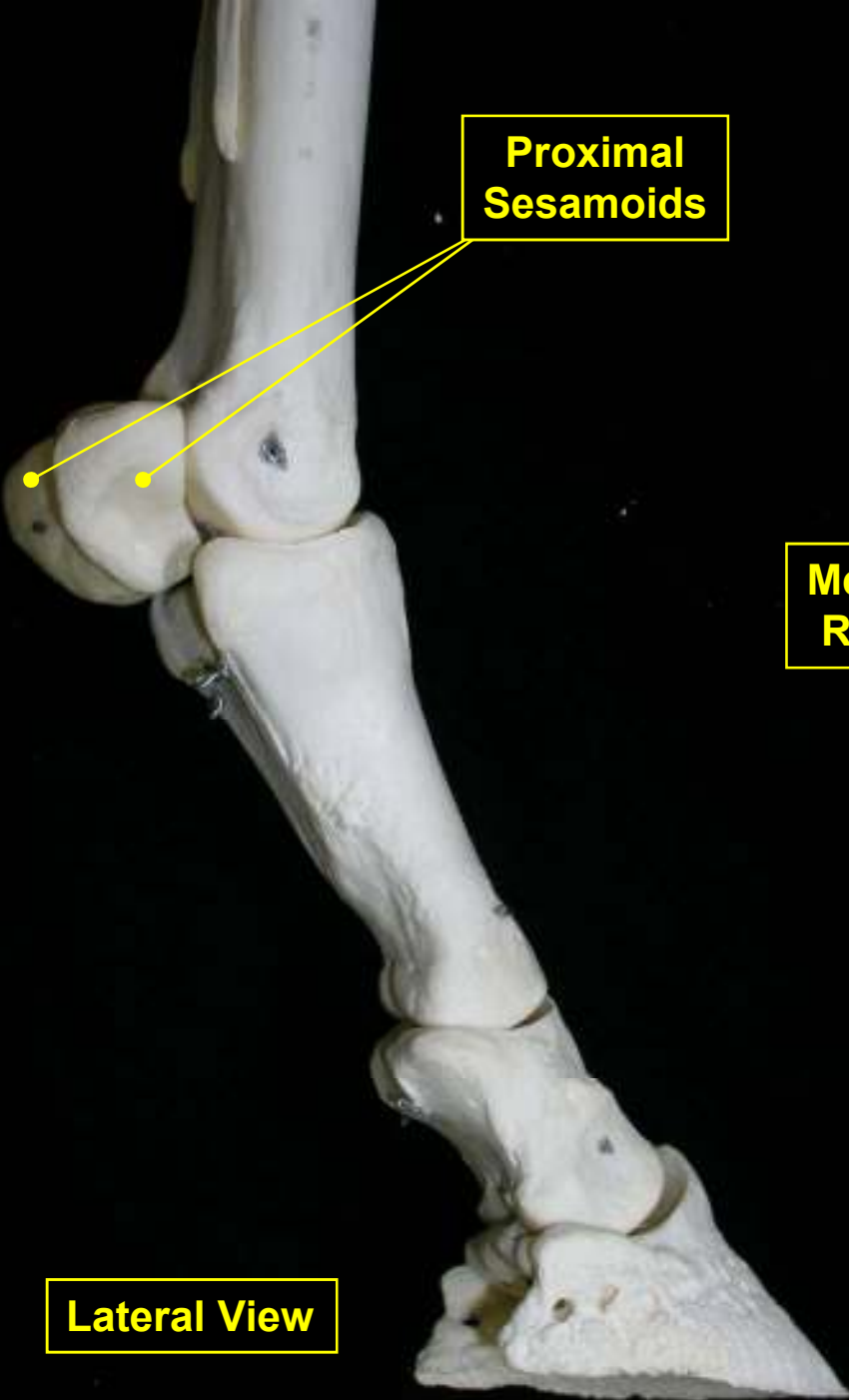
- Metacarpals cont.
 - The cannon bone of the horse is by far the strongest single bone in the body having a smaller medullary cavity than comparable sized bones of other species



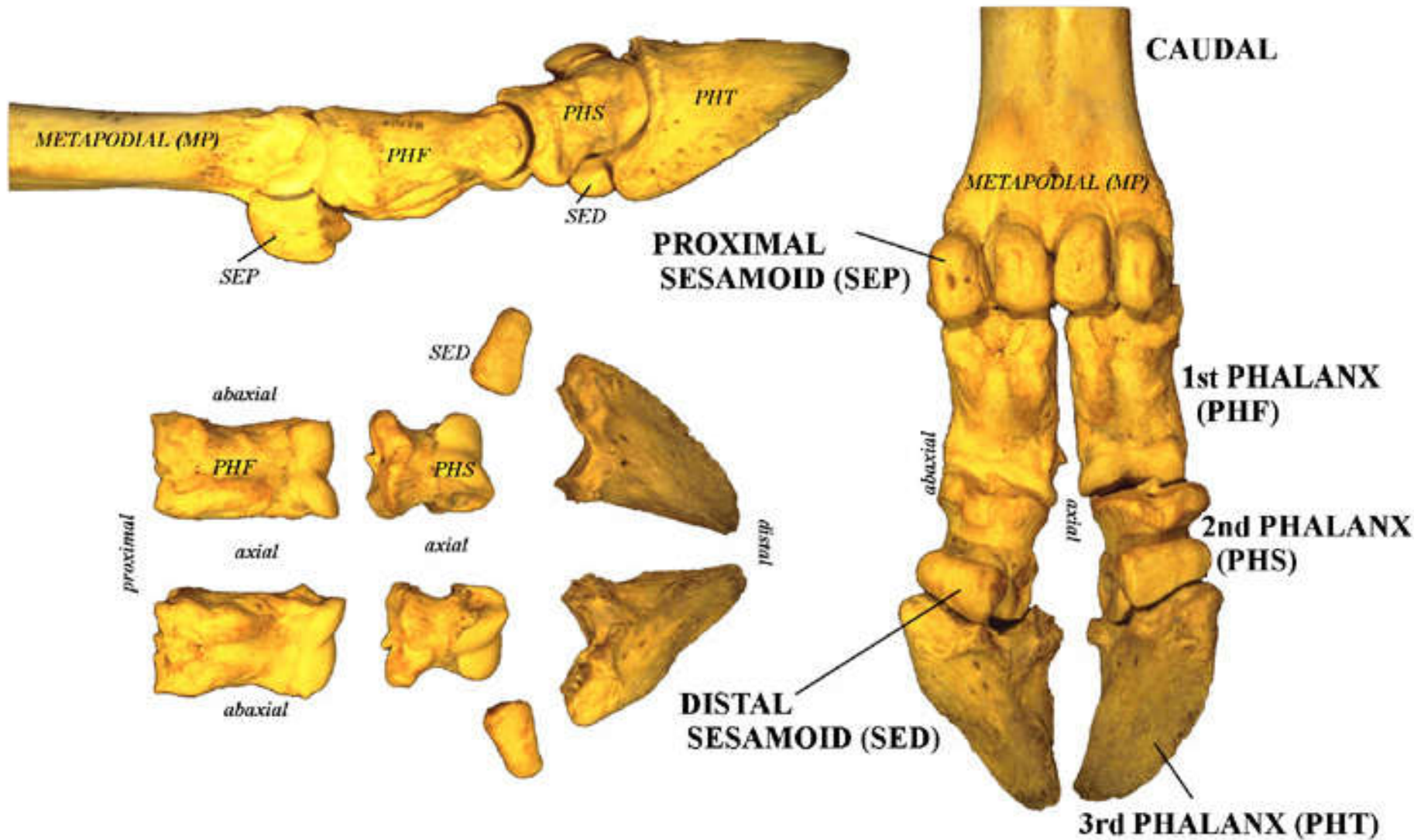
**Bovine
Metatarsal III + IV
Cross section**

**Equine
Metatarsal III
Cross section**

- Metacarpals cont.
 - The reduction of functional metacarpals in the ruminants and the horse lightened the manus and, along with an increase in length and adoption of an unguligrade posture allowed them to become faster runners than their digitigrade predators
 - The head of the metacarpal has a median ridge which articulates with the medial groove in the first phalanx
 - The proximal sesamoids articulate with the head of the metacarpal on either side of the medial ridge



PHALANGES (PH) AND SESAMOIDS (SE)



- **Phalanges**

- The phalangeal formula in the dog is 2-3-3-3-3. That is 2 phalanges on the first digit and 3 on the other four
- There are three phalanges on the functional digits of both the cow and the horse
- The first phalanx (P1) is the longest
- The third phalanx (P3) is either in the form of the claw (dog) or hoof (cow and horse)

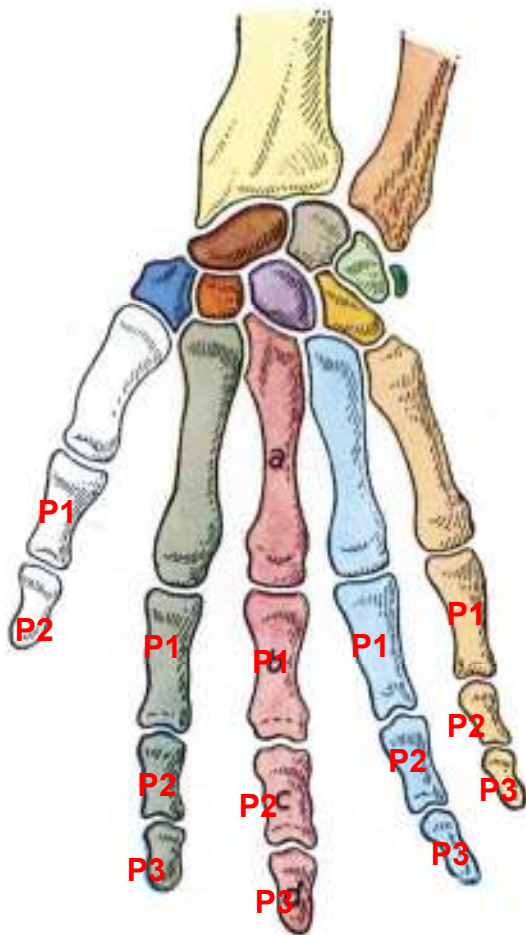


Fig. 116 (man)

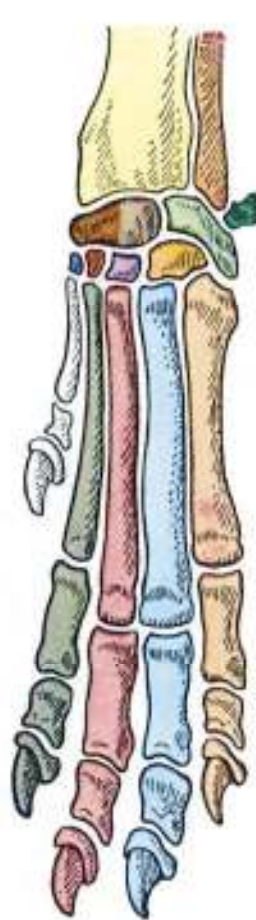


Fig. 117 (dog)

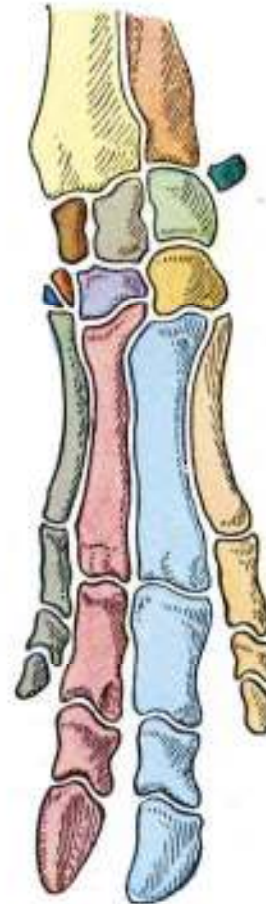


Fig. 118 (pig)

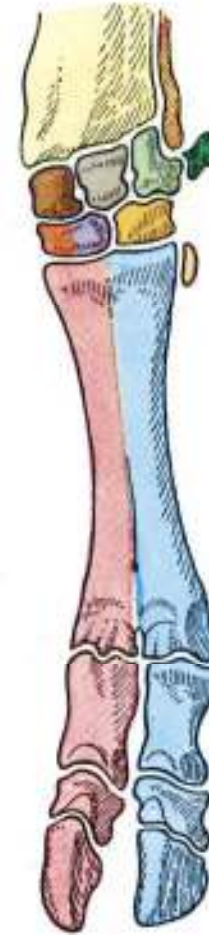


Fig. 119 (ox)

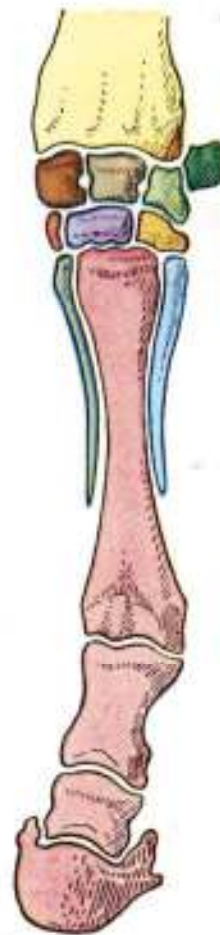
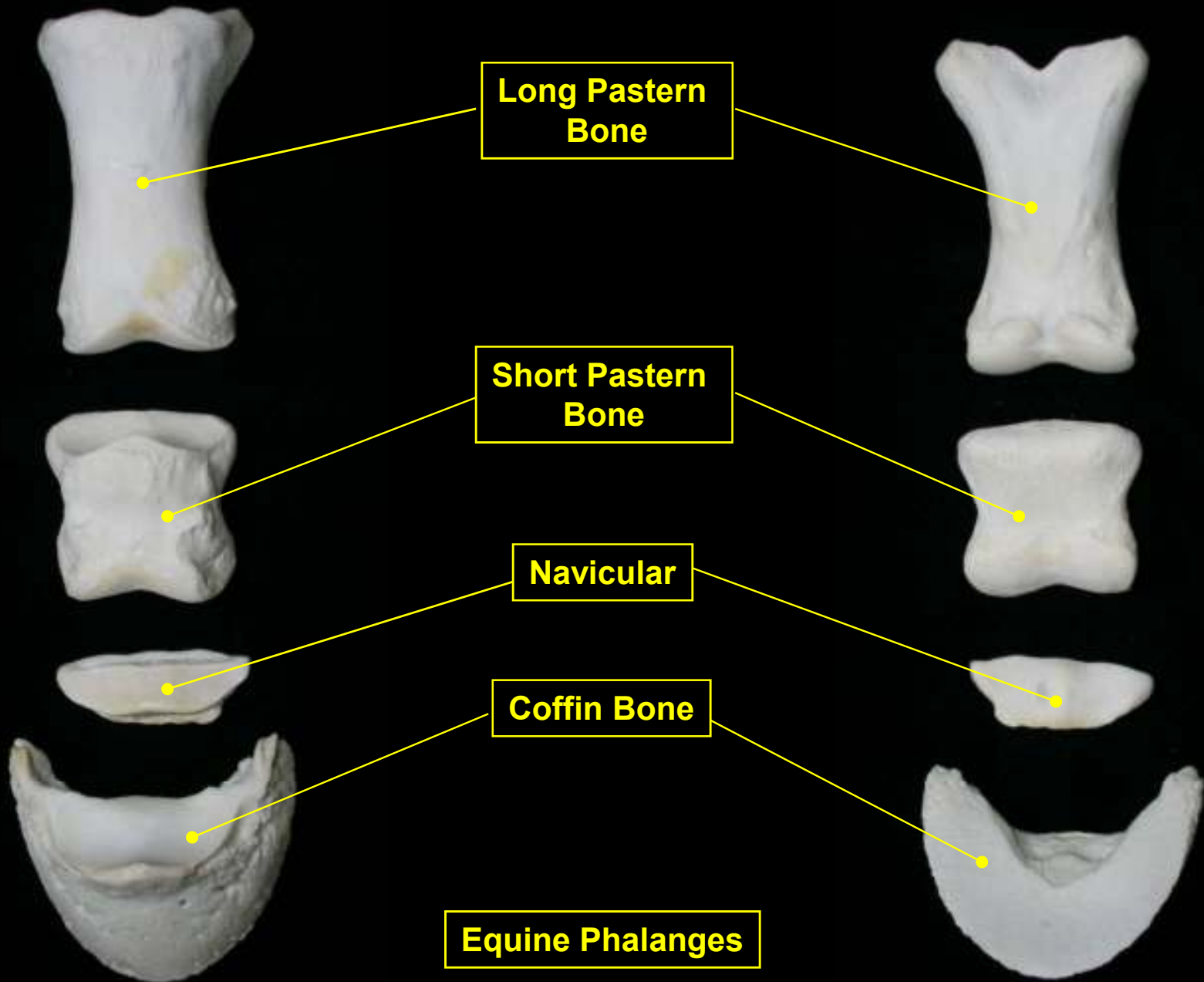


Fig. 120 (horse)

- Phalanges

- Horse

- P1 is referred to as the long pastern bone
 - The joint between the metacarpal and the first phalanx is referred to as the fetlock joint
 - P2 is referred to as the short pastern bone
 - P3 is referred to as the coffin bone
 - The distal sesamoid, or navicular bone, articulates on the caudal surface of the coffin bone and the distal surface of P2



Long Pastern Bone

Short Pastern Bone

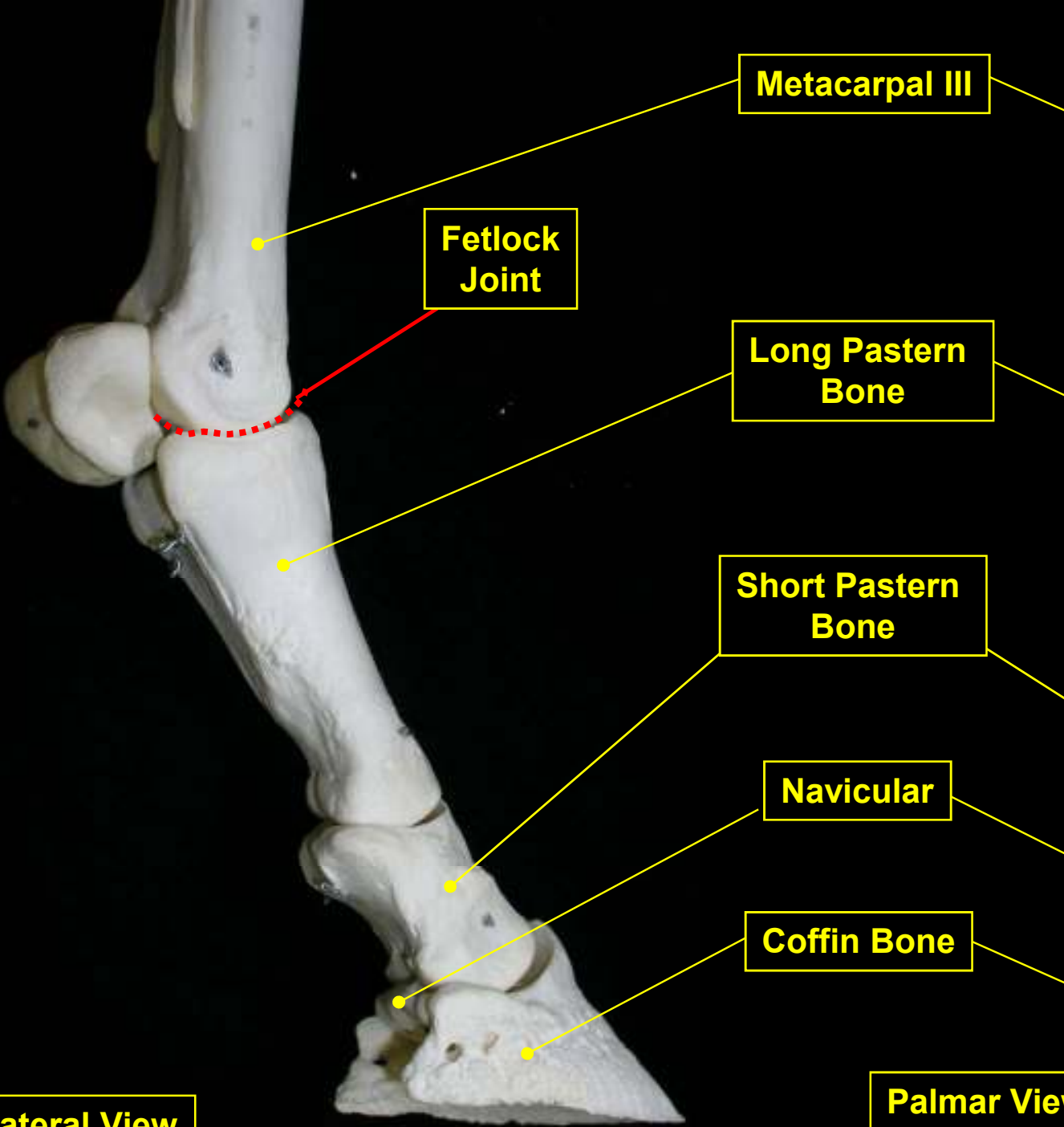
Navicular

Coffin Bone

Equine Phalanges

Dorsal View

Palmar View



Lateral View

Palmar View

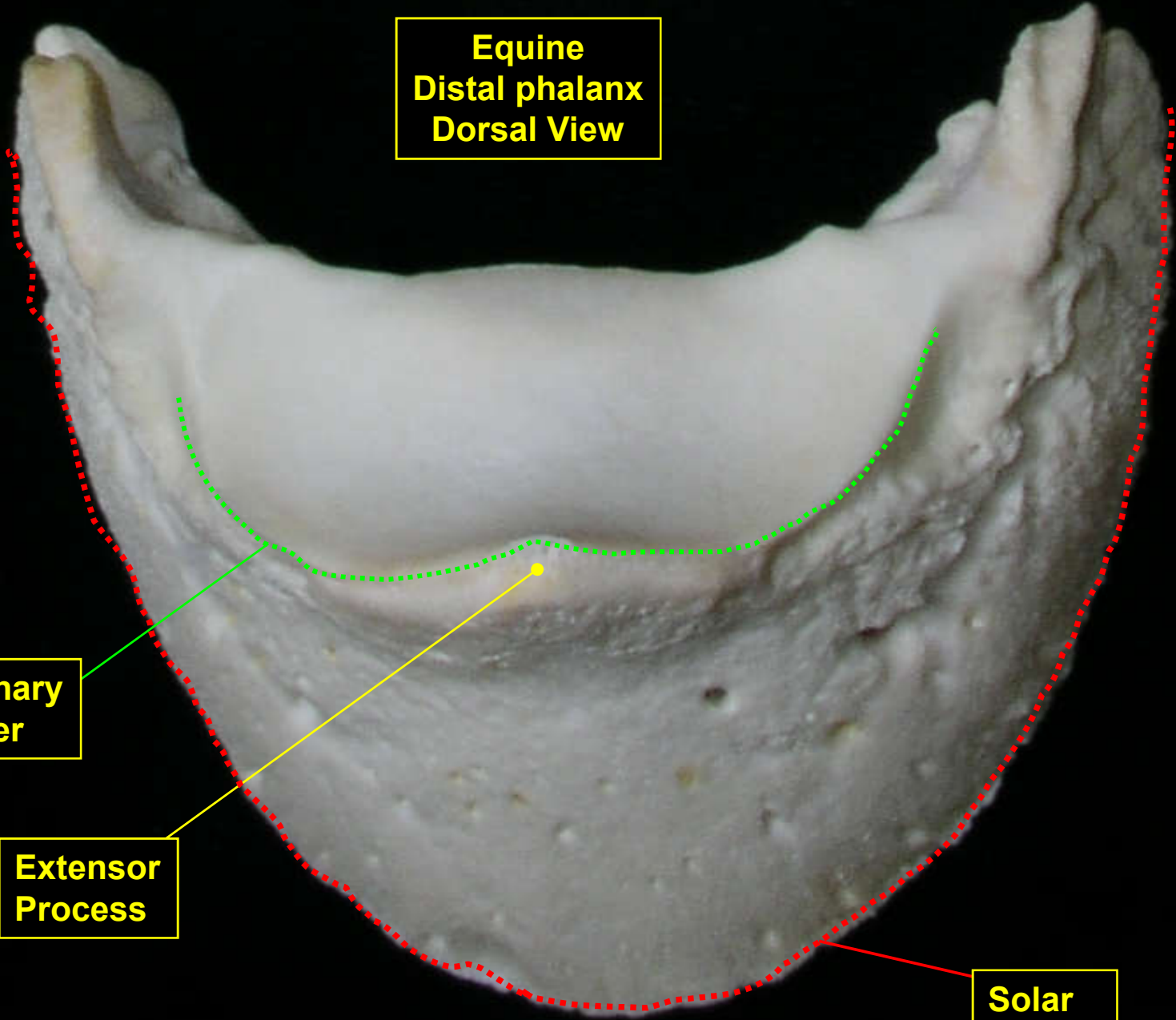


**Equine
Distal phalanx
Dorsal View**

**Coronary
Border**

**Extensor
Process**

**Solar
Border**



**Equine
Distal phalanx
Palmar View**

**Solar
Groove**

**Flexor
Surface**

**Semilunar
Line**

