



Comparative osteology:

Lets Learn about bones

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Attend the Class... 😊*

Divisions of the endoskeleton

Broadly, the endoskeleton is divided into two parts:

- 1. AXIAL SKELETON**
- 2. APPENDICULAR SKELETON**

Axial Skeleton:

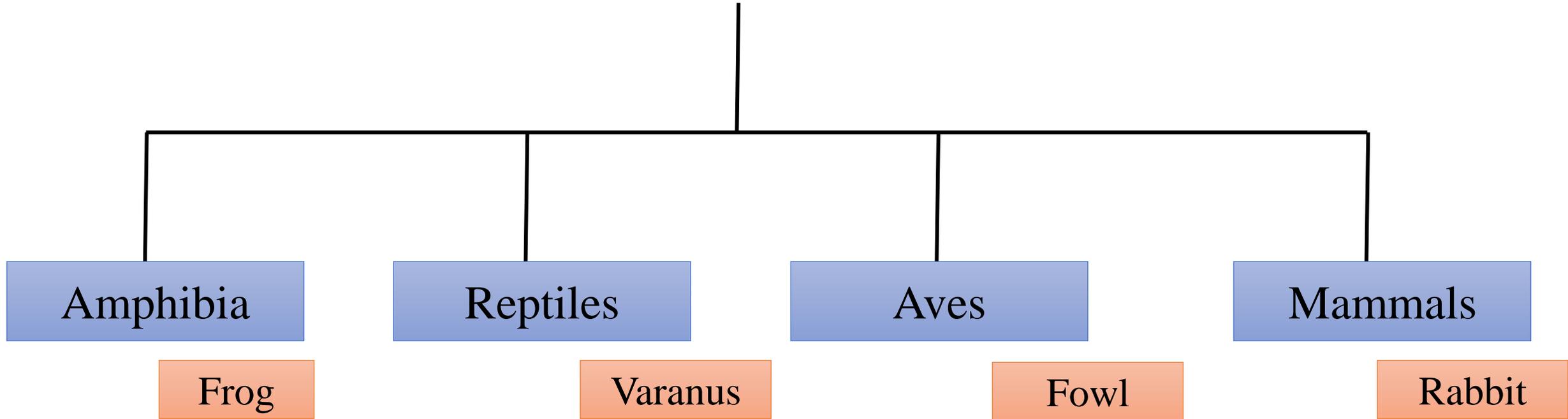
- Skull
- Vertebral column
- Ribs
- Sternum

Appendicular Skeleton

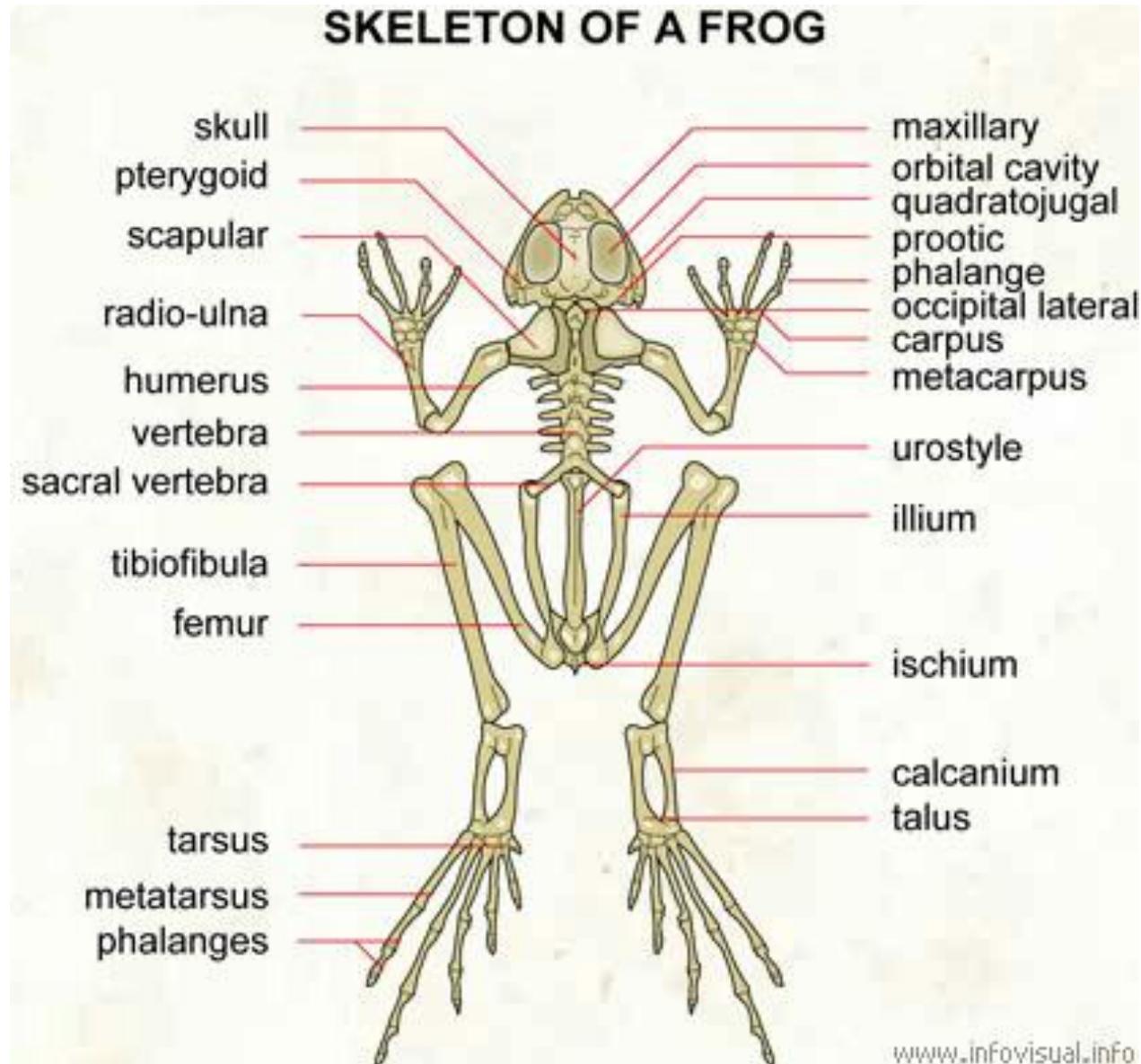
Girdles

Limb Bones

Comparative Osteology of Vertebrates



FROG



FROG SKULL

- **Dichondylic:** At the posterior end of the cranium is a foramen magnum surrounded by two exoccipitals. Each exoccipital bears at its posterior end a convexity, the occipital condyle which articulates with the concavity of the atlas vertebra.

Olfactory Capsules:

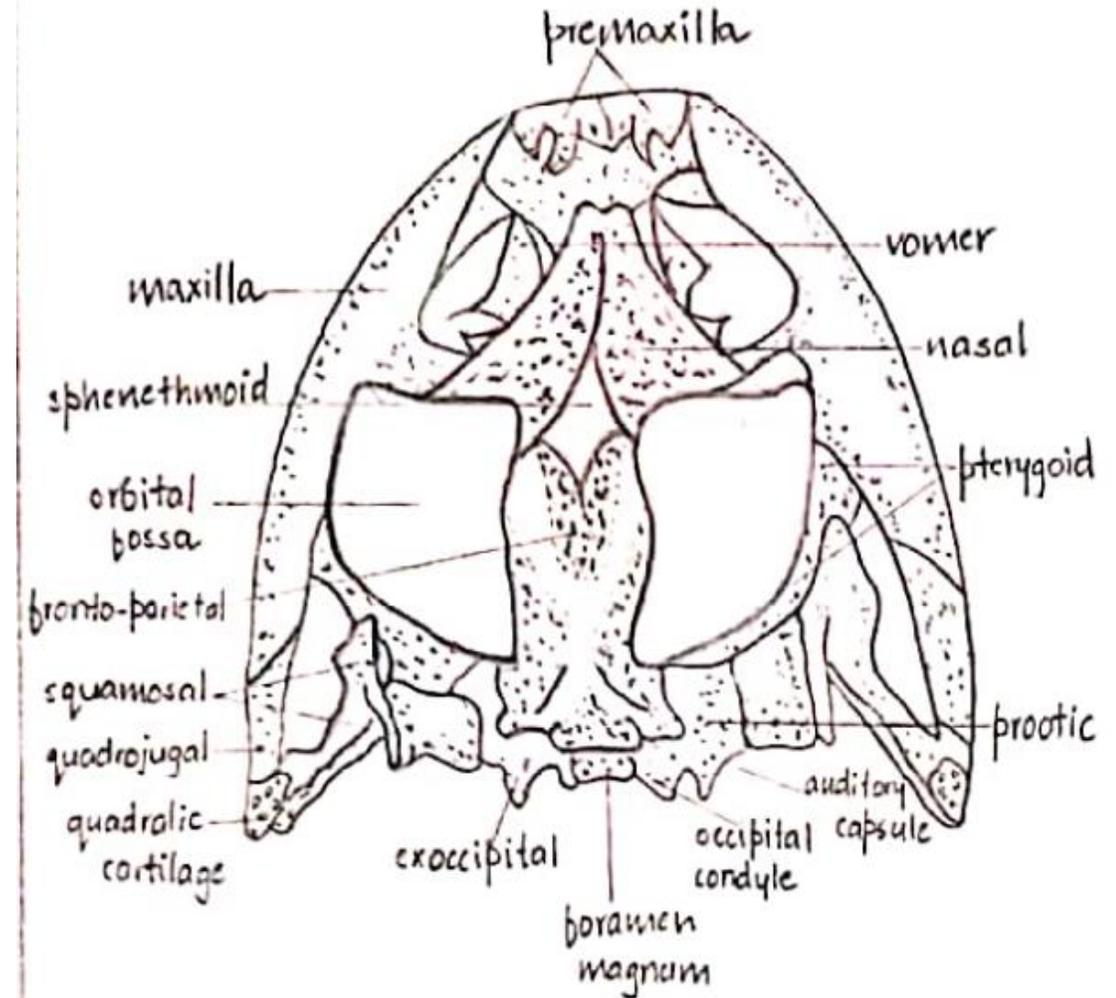
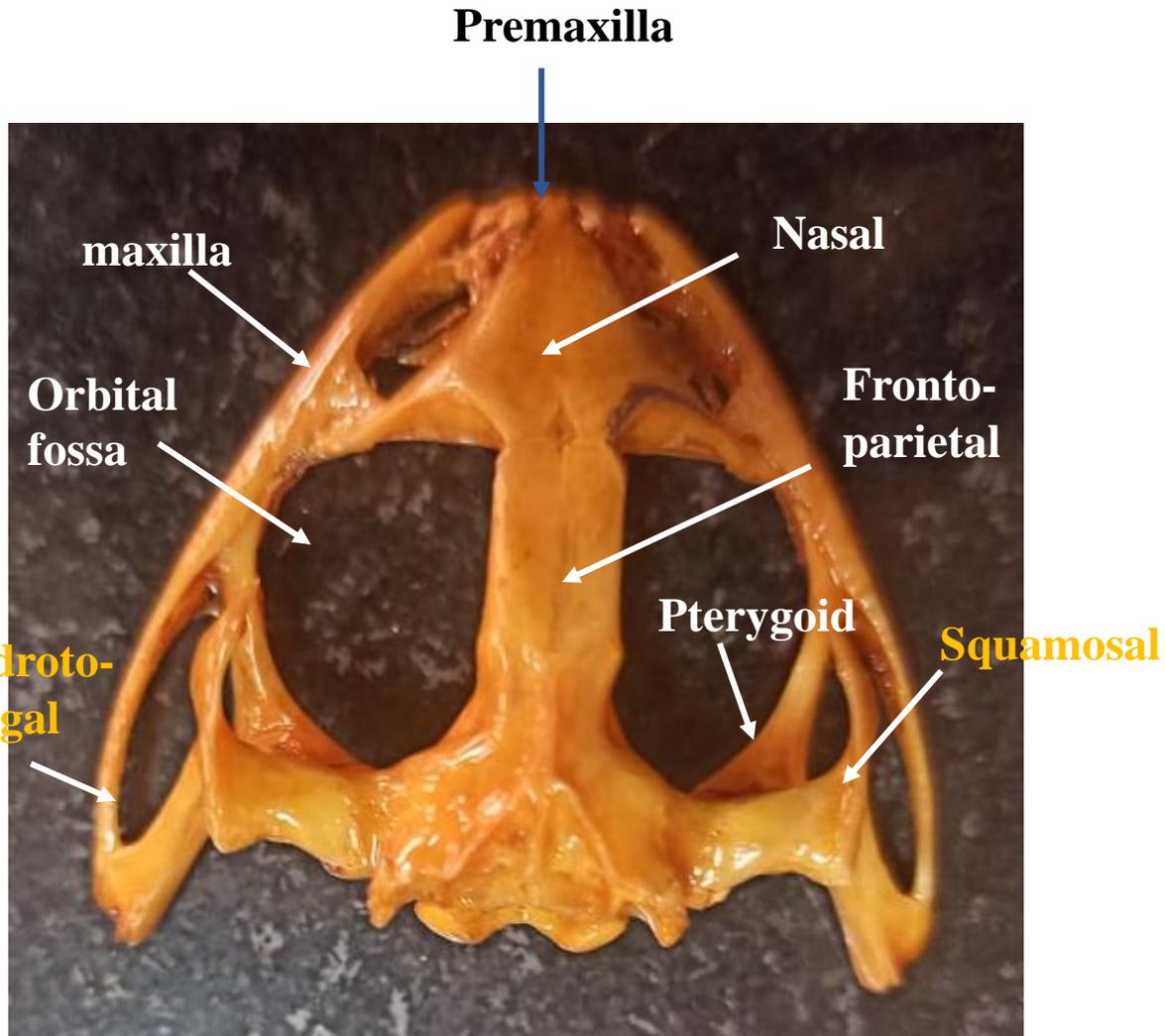
- The **olfactory capsules** have two **nasals** dorsally and two **vomers** ventrally, the vomers bear vomerine teeth.
- A pair of special bones called **septomaxillary (ethmoids)** form the boundary of nostrils. They are associated with and surround the Jacobson's organ.

Optic Capsules:

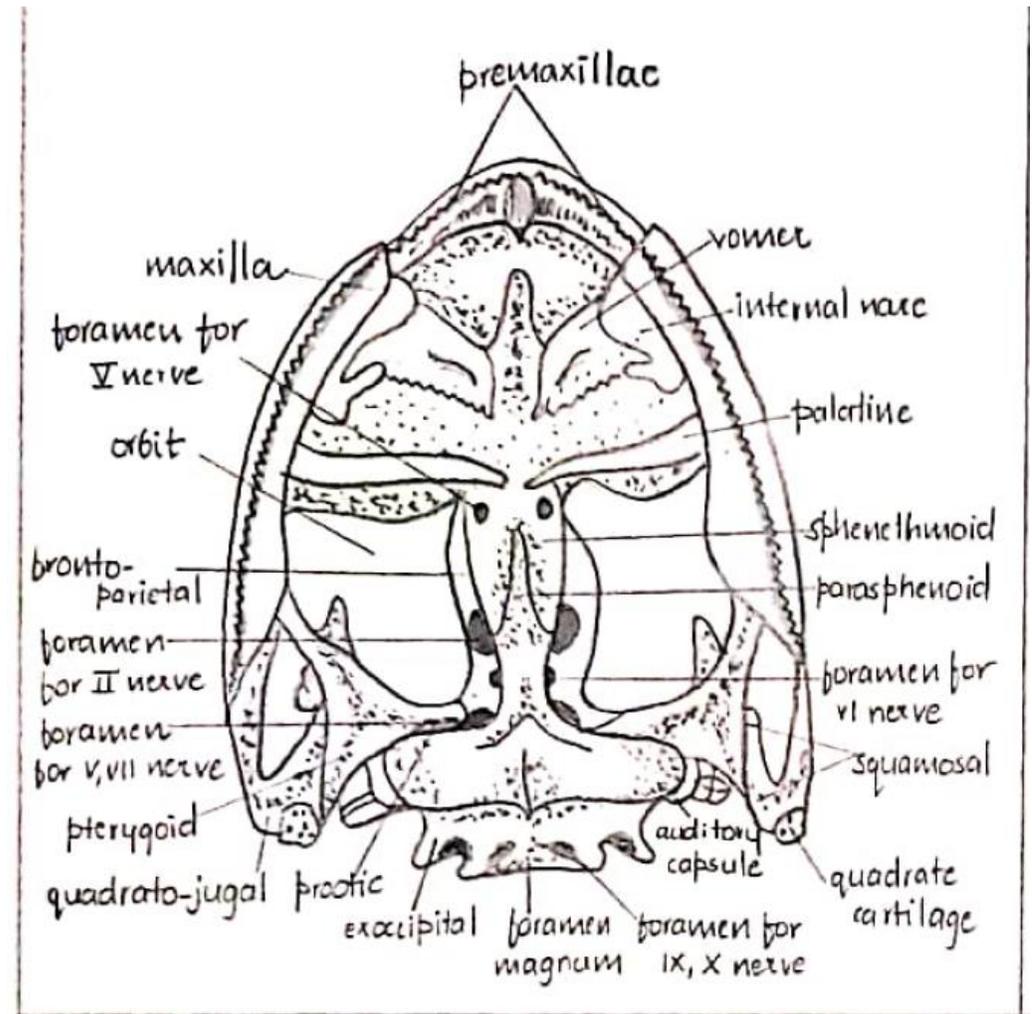
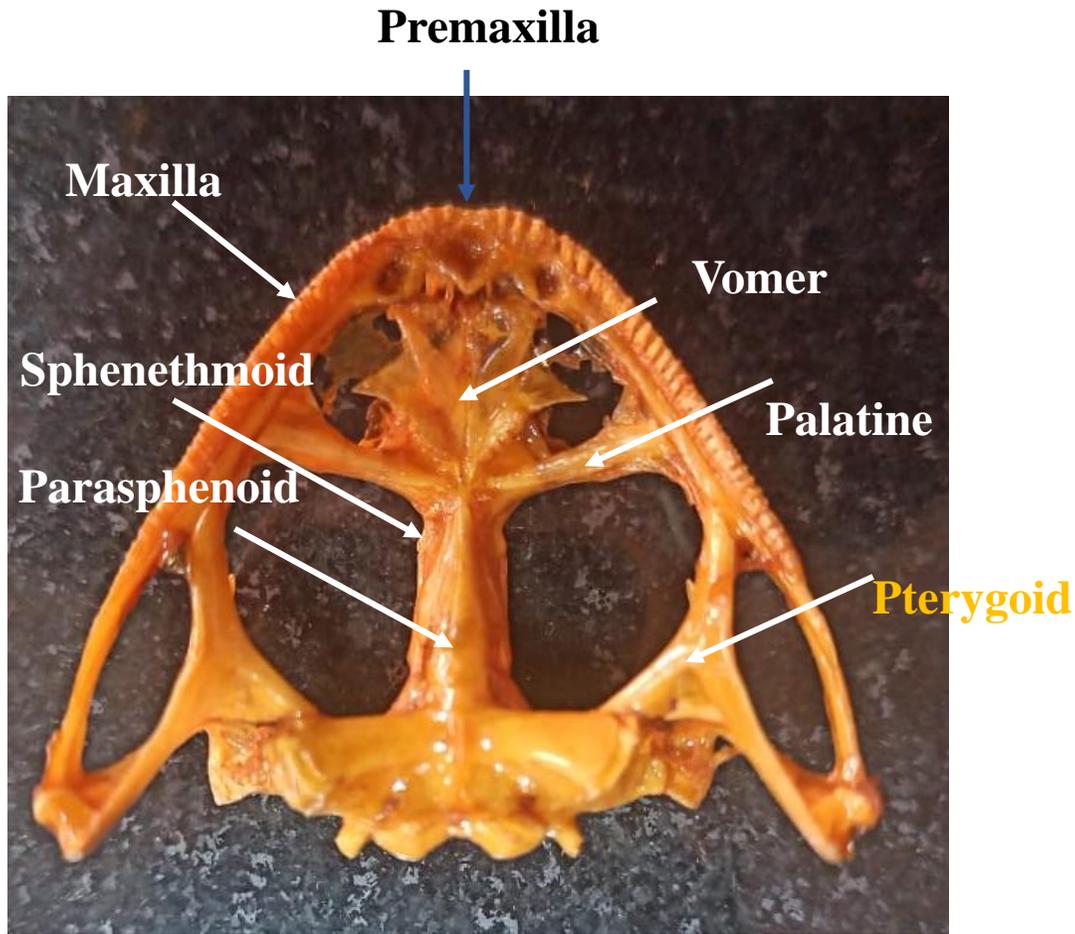
- They enclose the eyes and are not fused with the skull.

- **Upper Jaw:**
- The upper jaw **has two halves**, each half has an anterior **premaxilla** followed by a long **maxilla**, both bear teeth.
- The posterior part of the upper jaw has a small **quadratojugal**. Its broad posterior end unites with quadrate cartilage, which is a small thin rod forming the suspensorium.
- The mandible articulates with the quadrate cartilage.
- Ventral anterior to the orbit is a slender, rod-like **palatine**.
- At the posterior lateral end of cranium is present a large 3-rayed or Y-shaped **pterygoid**.
- It articulates anteriorly with the maxilla and palatine and on the inner side with the parasphenoid and auditory capsule, and posteriorly with the quadratojugal and quadrate cartilage.
- At the posterior dorsolateral end of cranium is the hammer-shaped bone, the **squamosal**.
- It lies above the pteryoid. Its anterior limb or head is free and the short posterior limb articulates with the auditory capsule and prootic. Its handle joins with the quadrate cartilage.

Frog Skull: Dorsal View



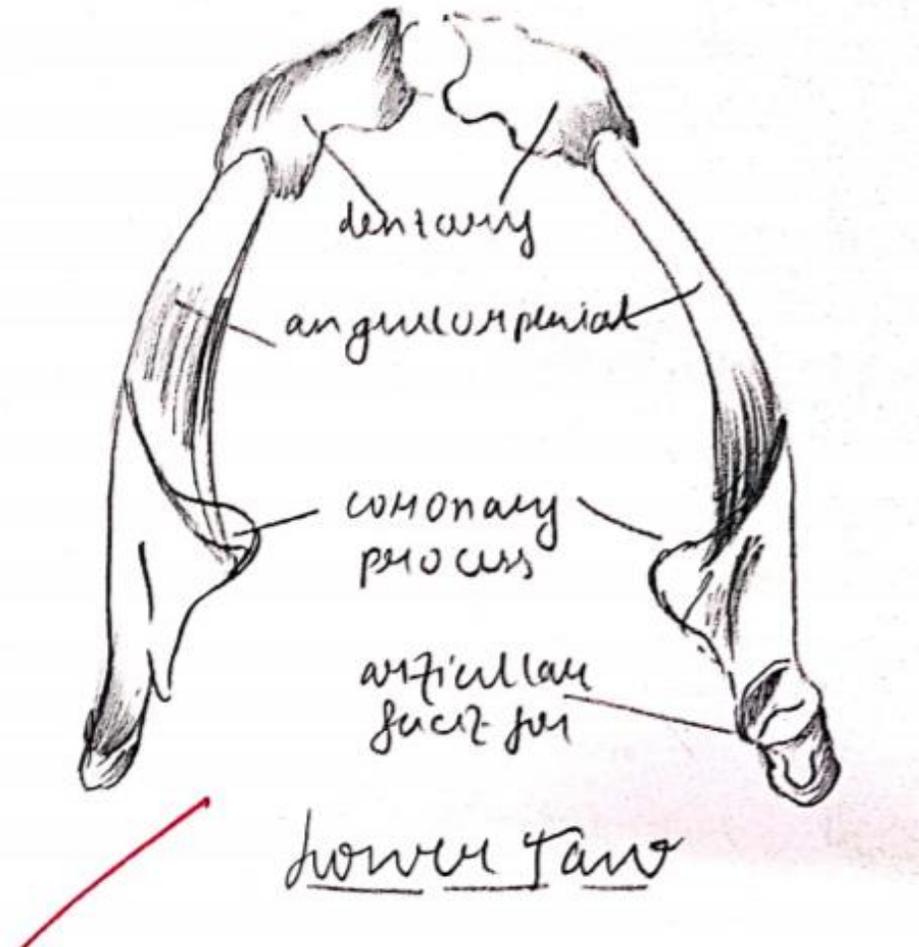
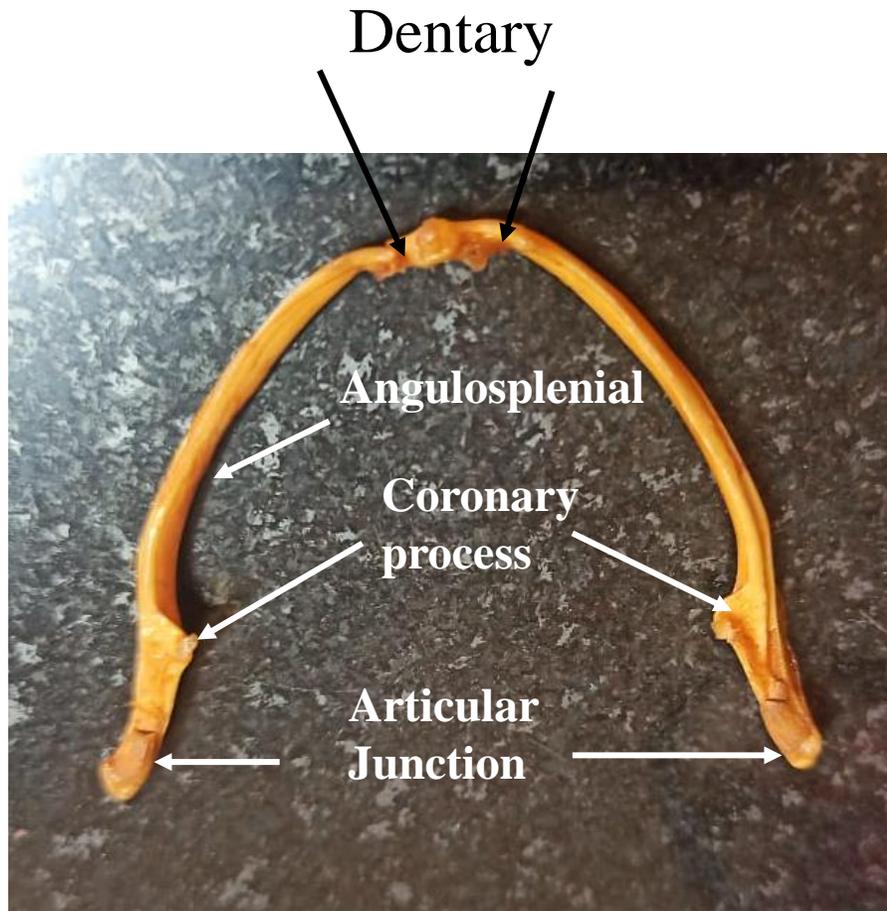
Frog Skull : Ventral View



Frog: Lower Jaw

- Two rami joined in front by elastic ligament.
- Each half has a core of Meckel's cartilage covered over by an angulosplenic forming the inner and posterior portion of each ramus.
- Just anterior to the condyle is present the **coronary process**.
- Anterior outer surface of Meckel's cartilage is covered by a small, flat, dogger-like **dentary**.

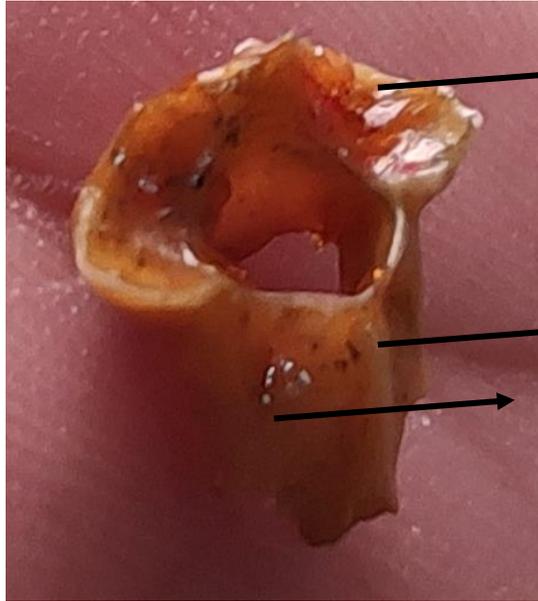
Frog Lower Jaw



Frog Vertebrae

- **Atlas Vertebra:**
- The first vertebra
- It is ring-like in form.
- Centrum and neural spine are reduced.
- Transverse processes and prezygapophysis are **absent**.
- The neural arch is large.
- The anterior face of centrum possesses a pair of concave facets for the articulation with the occipital condyles of the skull. (dichondylic)
- The posterior margin of the neural arch bears a pair of postzygapophyses.

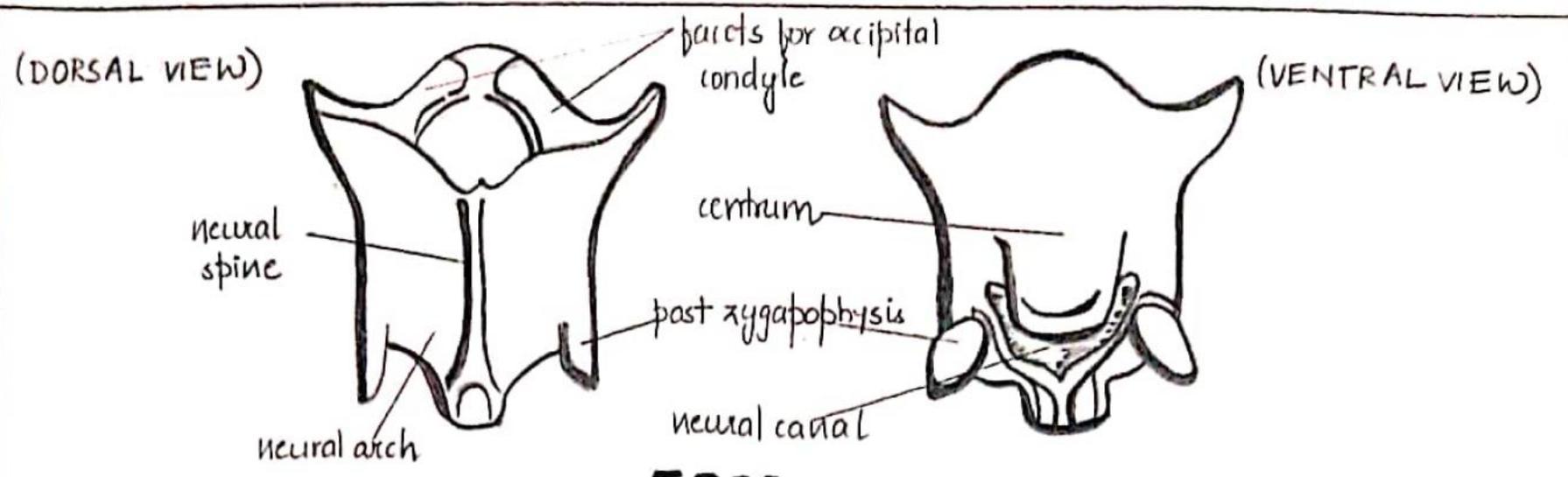
FROG ATLAS



Facets for Occipital Condyle

Neural Spine

Neural Arch



(DORSAL VIEW)

facets for occipital condyle

neural spine

neural arch

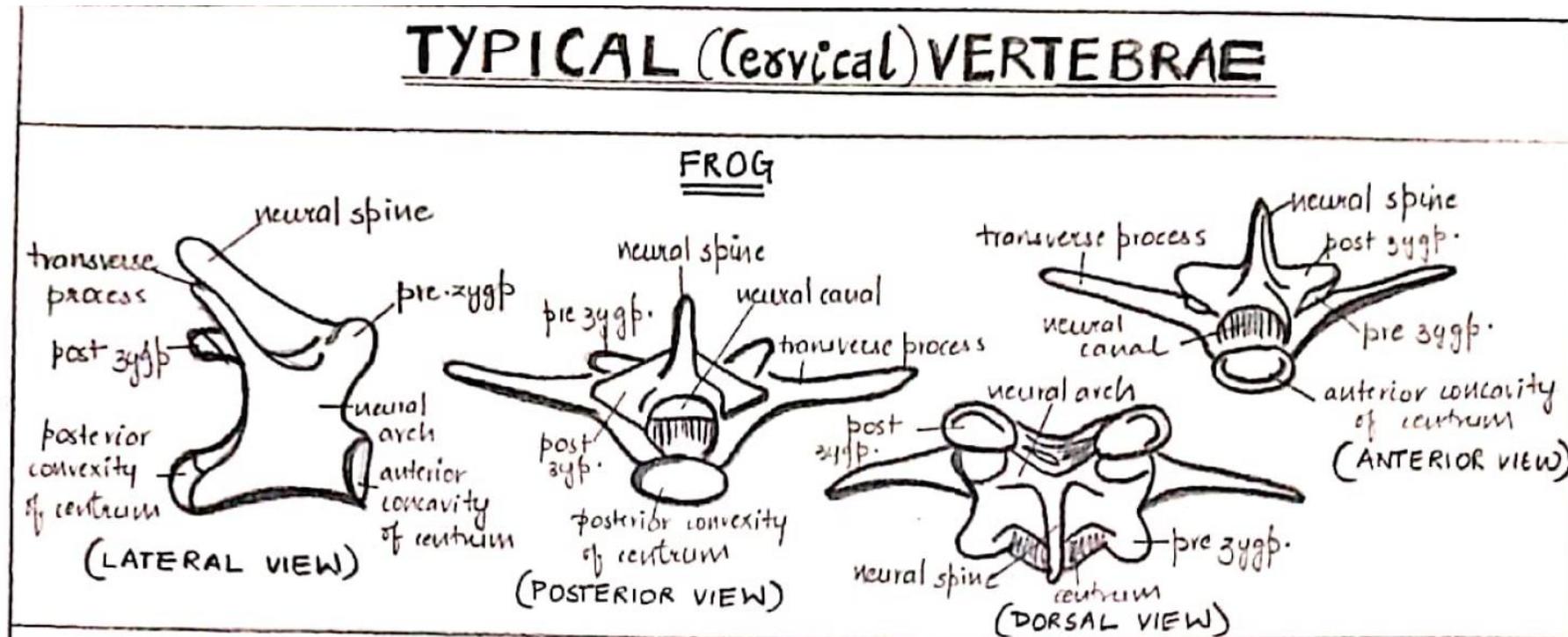
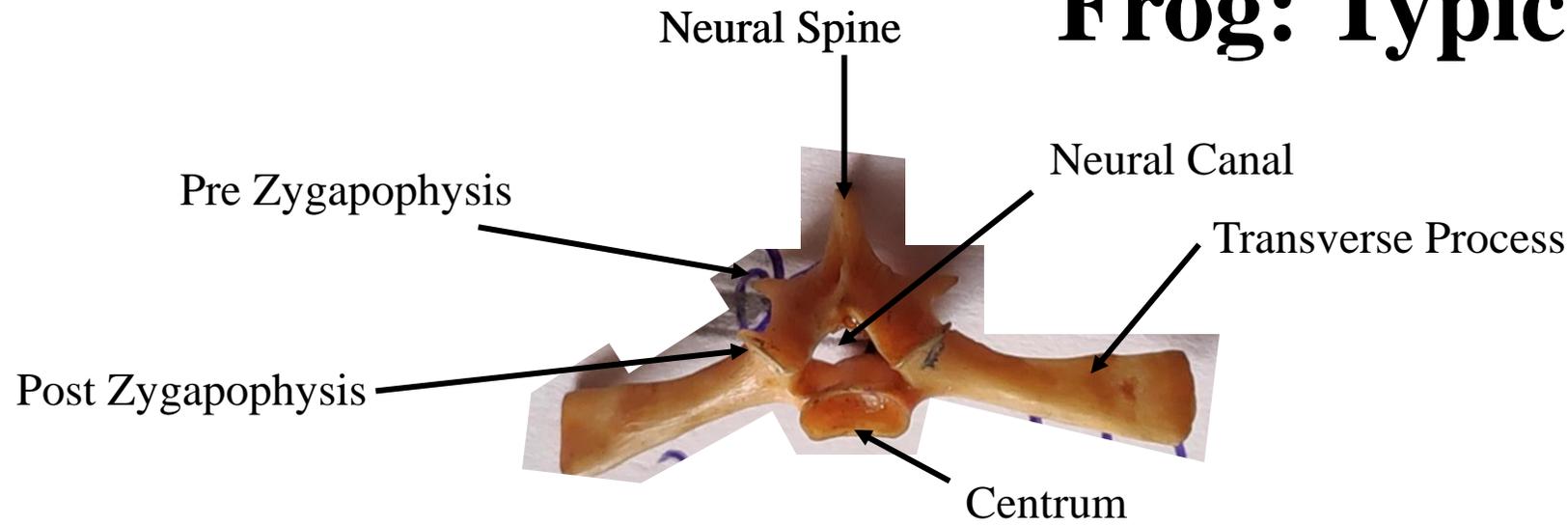
centrum

post zygapophysis

neural canal

(VENTRAL VIEW)

Frog: Typical Vertebra



- **Typical Vertebra:**

- The centrum is procoelous, i.e., it is concave in front and convex behind.
- On the dorsal side, the centrum bears a neural arch which encloses the neural canal.
- The neural arch possesses a backwardly directed spinous process or neural spine.
- The lateral sides of the neural arch carry transverse processes.
- The neural arch possesses two articulating processes. The **prezygapophyses** and the **postzygapophyses**.

SOME UNIQUE VERTEBRA

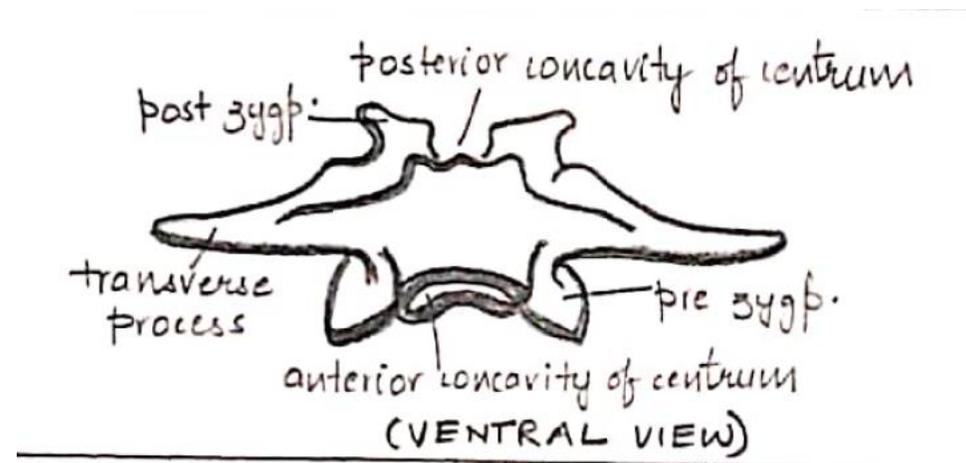
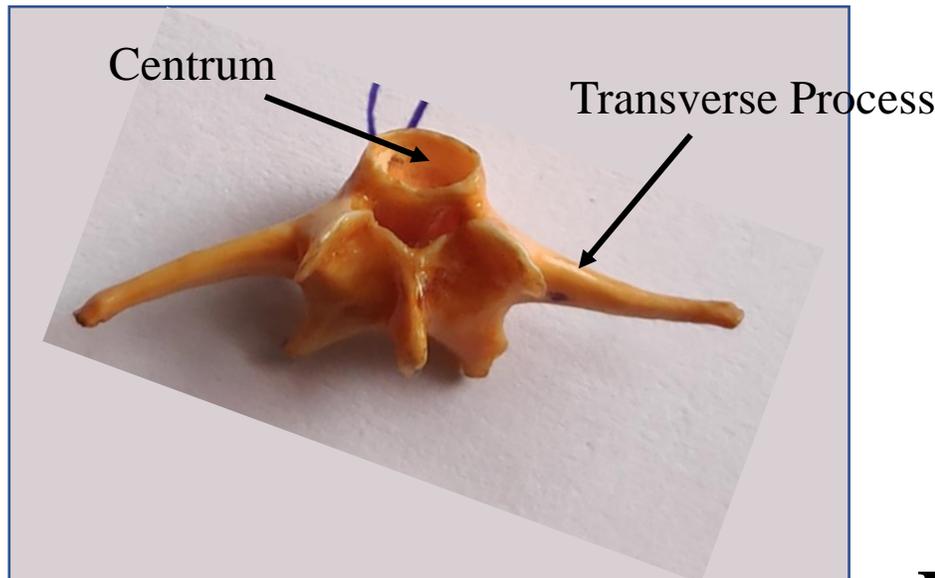
- **Eighth Vertebra**

The centrum of eighth vertebra is amphicoelous, i.e., concave on both the sides.

The anterior concavity receives the posterior convexity of the VIIth vertebra.

Transverse processes are long, slender and outwardly directed.

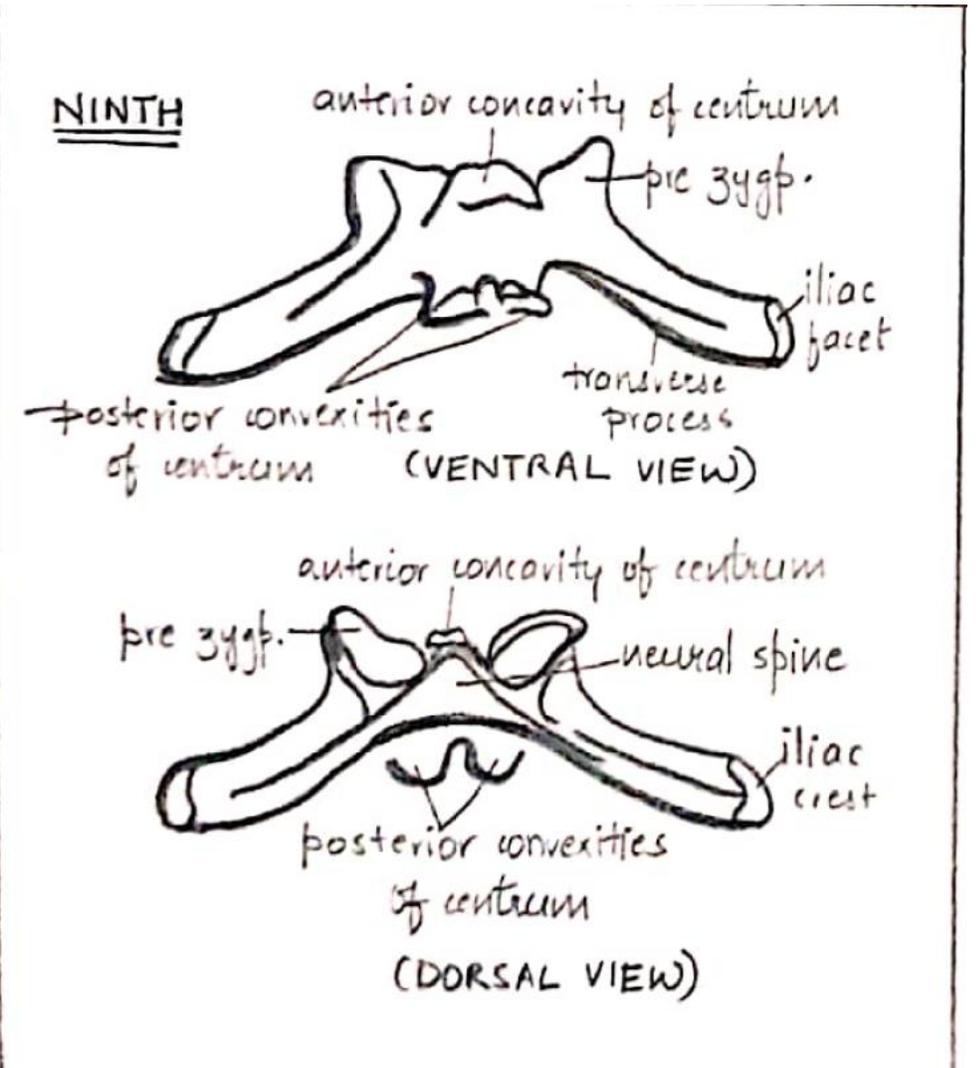
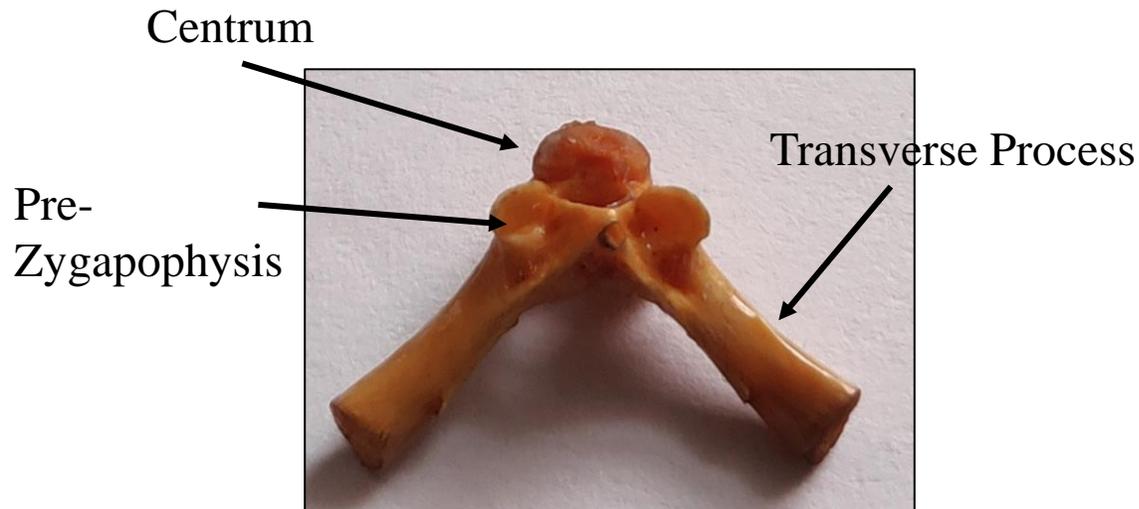
Prezygapophyses and postzygapophyses are present on the anterior and posterior margins of the neural arch respectively.



Frog: Eighth Vertebra

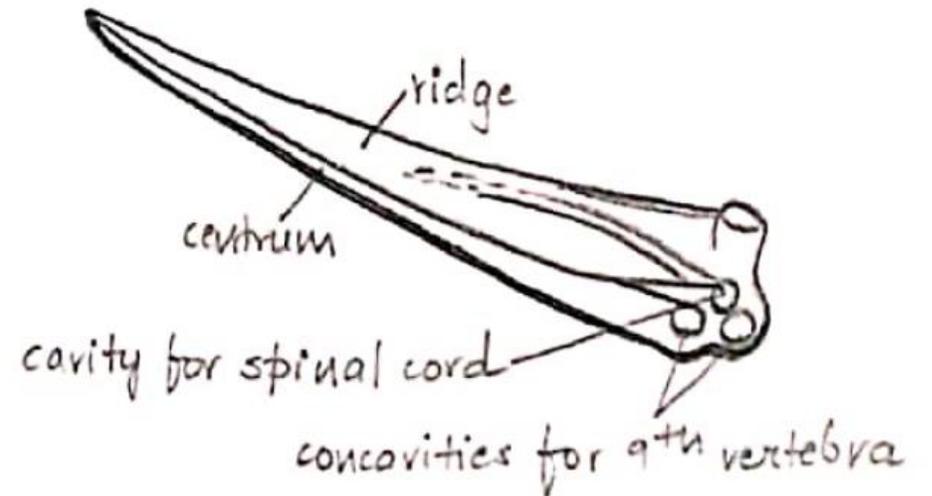
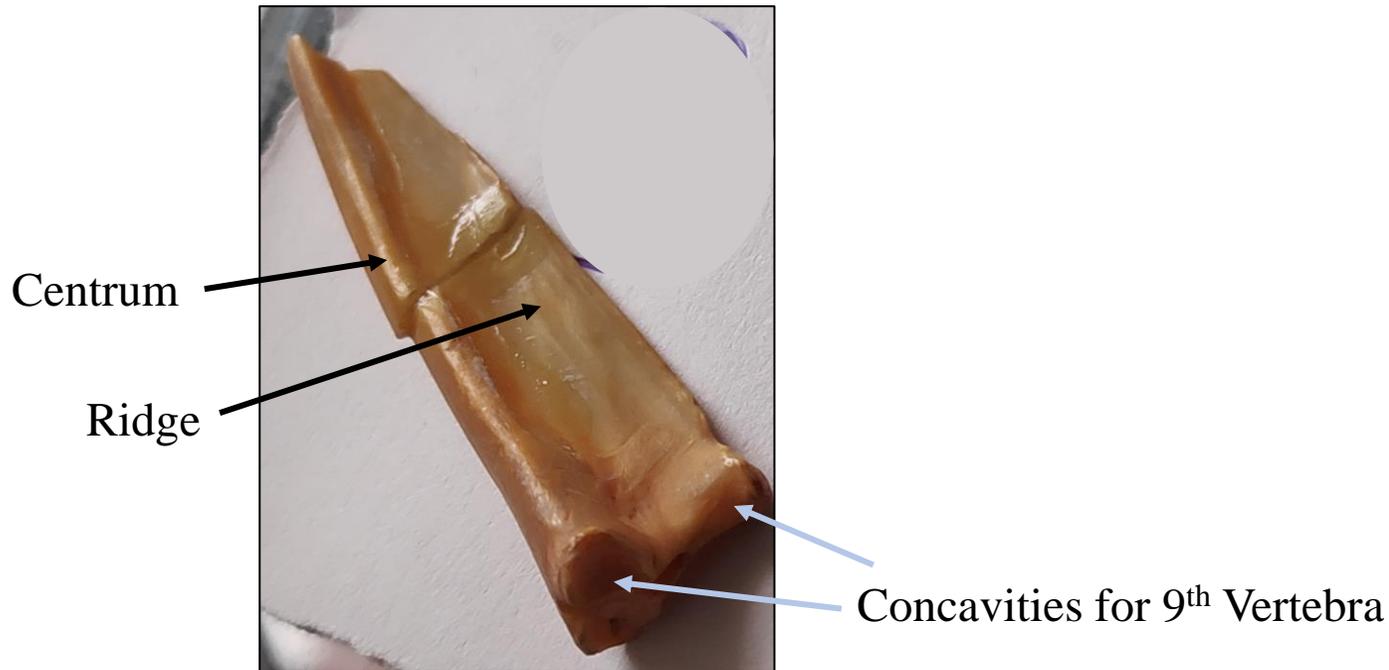
Frog: Ninth Vertebra

- **Ninth Vertebra:**
- The ninth vertebra is also known as sacral vertebra.
- The centrum of ninth vertebra is biconvex, i.e., convex on both the sides (bearing one convexity anteriorly and two convexities posteriorly).
- The anterior convexity fits into the posterior concavity of eighth vertebra.
- The posterior convexities fit into the anterior concavities of urostyle.



Frog: Urostyle

- Represents the caudal region of frog.
- Long and triangular.
- Pointed apex directed backwards

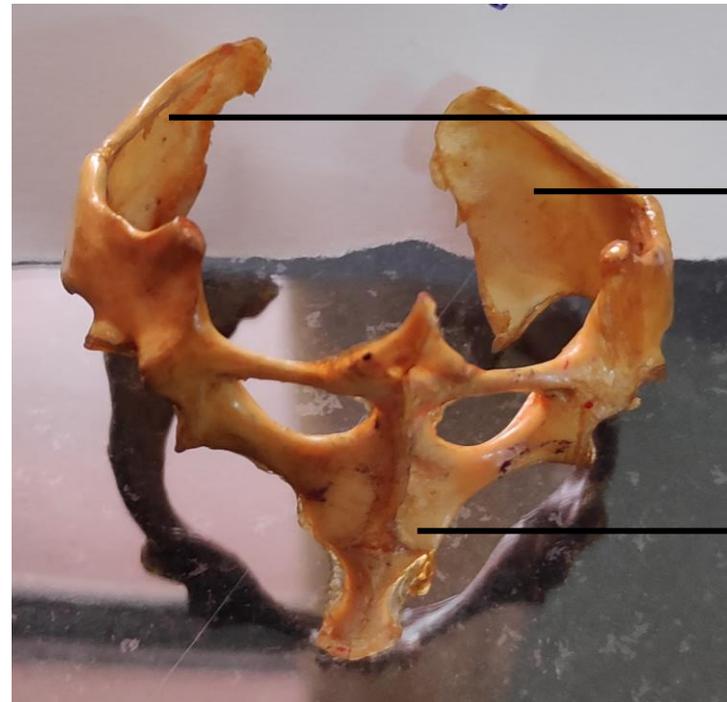
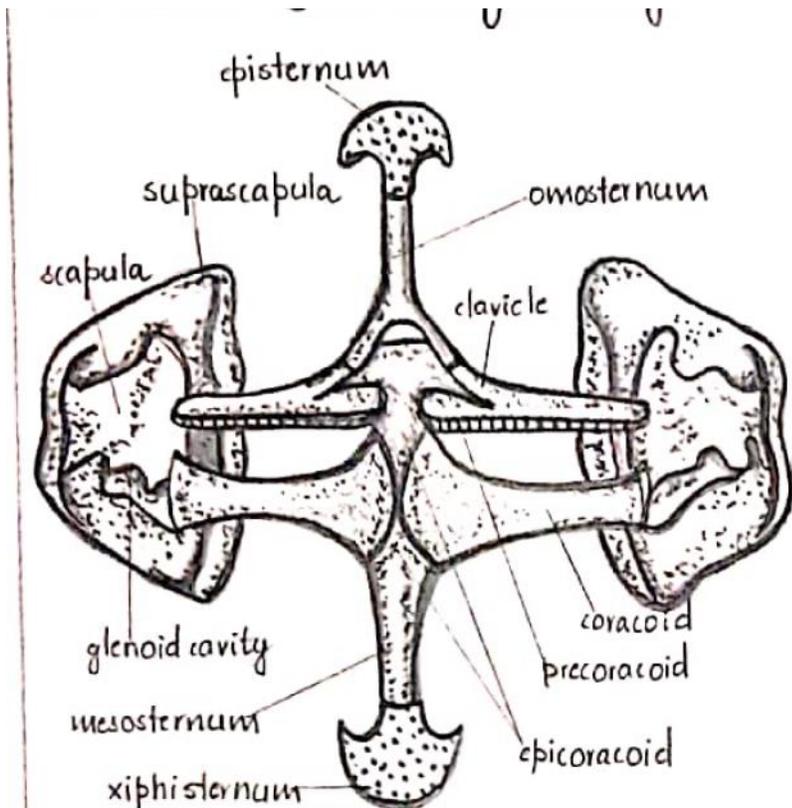


FROG PECTORAL GIRDLE

- Present in the thoracic region.
- Provides attachment to the forelimbs and their muscles.
- It consists of two similar halves permanently attached with sternum.
- Each half is divided into a dorsal **scapular portion** and a ventral **coracoid portion**.
- The scapular portion comprises the **suprascapula** and **scapula**.

Coracoid Portion:

The coracoid portion comprises the clavicle, coracoid, precoracoid and epicoracoid. Clavicle (a slender rod) and coracoid (dumb-bell-shaped) meet mid-ventrally with the sternum and their counterparts of other side by a strip of cartilage, the epicoracoid.



Two halves of the
Pectoral Girdle

Sternum

STERNUM OF FROG

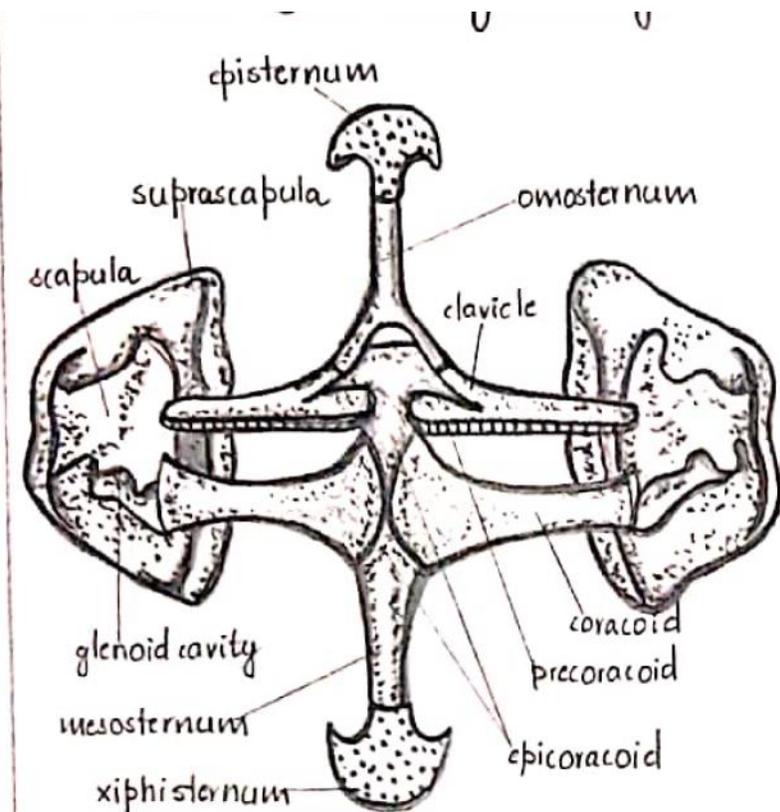
- It lies midventrally connected between the two halves of pectoral girdle. It is composed of four parts:
 - Anterior to the **clavicle** lies an inverted Y-shaped bony **omosternum** which is anteriorly attached with the rounded, flat cartilaginous **episternum**.
 - Posterior to the epicoracoid and coracoids is a bony rod-like sternum proper or **mesosternum** to which is attached a broad cartilaginous **xiphisternum** posteriorly.



Clavicle

Mesosternum

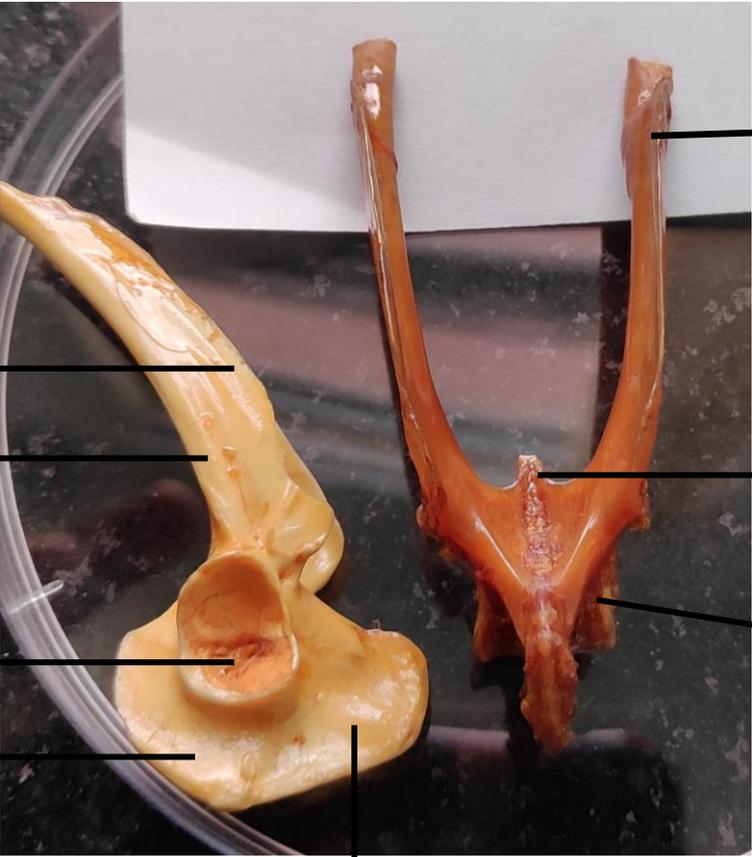
Xiphisternum



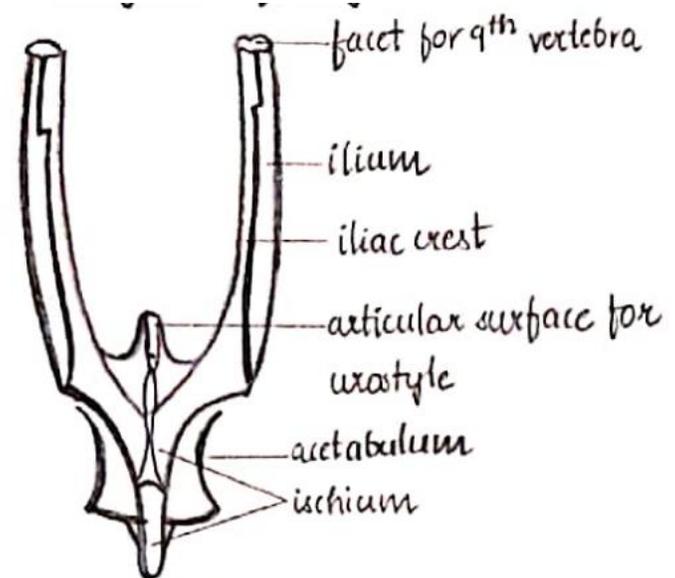
PELVIC GIRDLE FROG

- It is V-shaped and composed of two similar halves, each of which is known as os-innominatum.
- Each os-innominatum is composed of three bones, ilium, pubis and ischium, which form the disc and the acetabulum.
- **Ilium** is greatly elongated and forms the major part of each os-innominatum. It runs forwards to meet the transverse process of the ninth vertebra.
- Pubis is much reduced. It is a triangular piece of calcified cartilage, forming the central part of the disc and a small part of the acetabulum. Both the pubes are also fused.
- Ischium is larger and slightly oval bone and both the ischia fused in the middle and form one- third part of the disc and acetabulum.

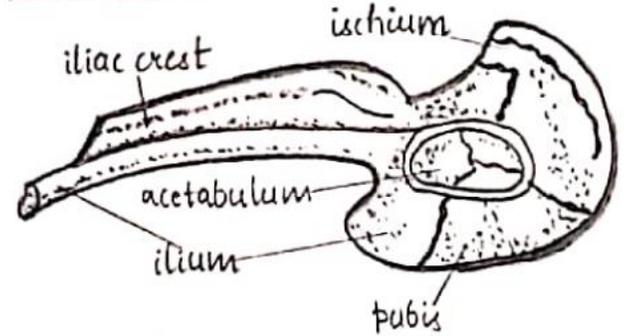
PELVIC GIRDLE FROG



Ilium
Iliac Crest
Ilium
Acetabulum
Pubis
Ischium
Articular Surface for Urostyle
Acetabulum



DORSAL VIEW



Appendicular Skeleton: Limb Bones

Fore Limbs of Frog

1. HUMEROUS:

- short, cylindrical, slightly curved bone of upper arm.
- Proximal end fits into glenoid cavity of pectoral girdle. Swollen: forming the **head**, covered by calcified cartilage.
- Below head: deltoid ridge for muscle attachment.
- Distal end has a prominent **trochlea** or **capitulum** and **condylar ridge** for articulation with radio-ulna.

FROG: HUMEROUS



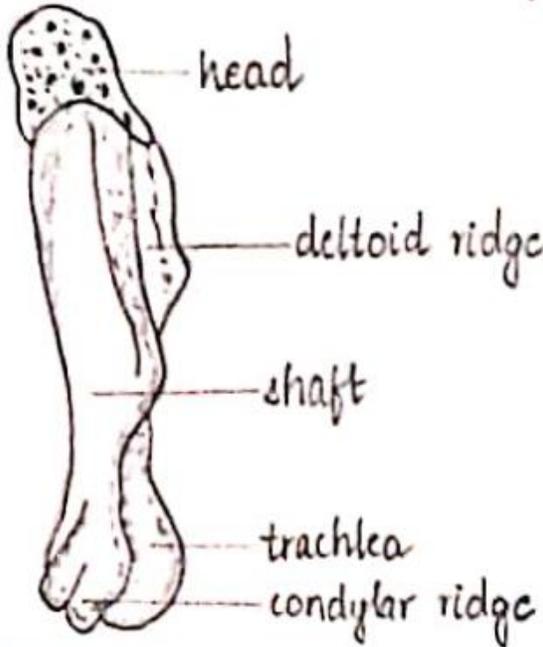
Head

Deltoid Ridge

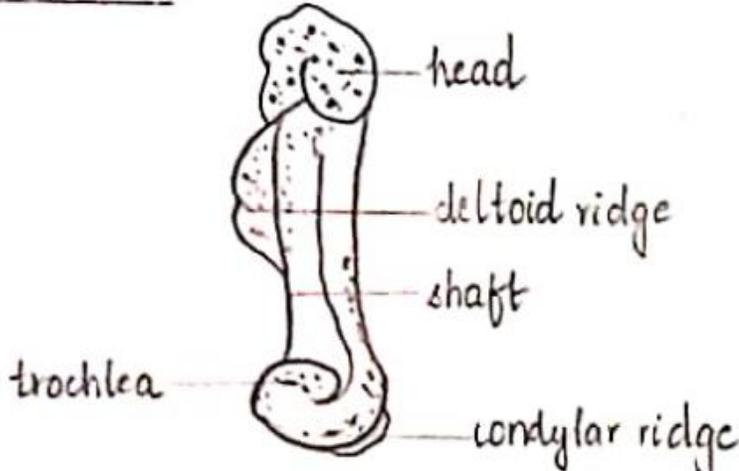
Shaft

Trochlea

Condylar Ridge



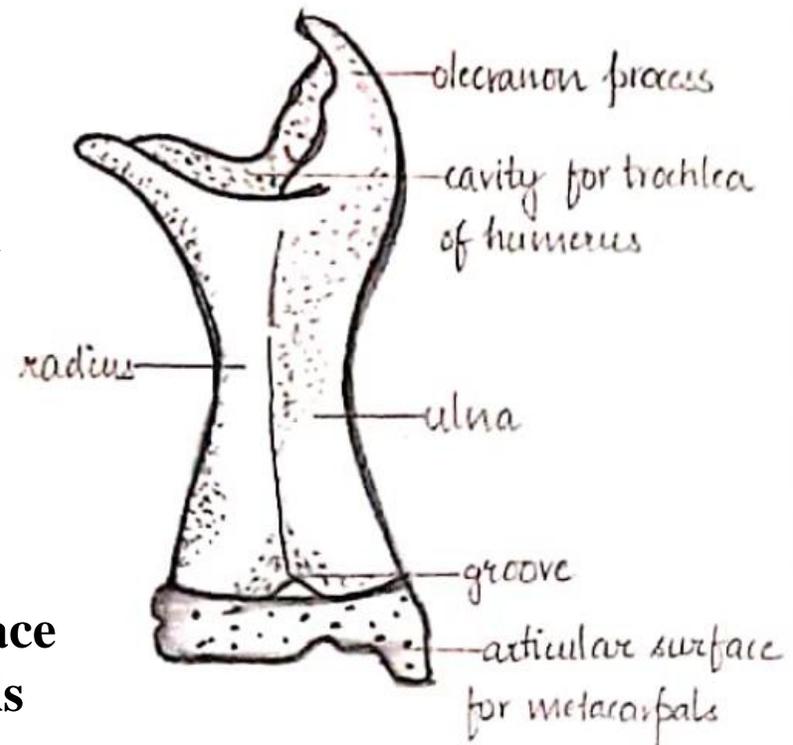
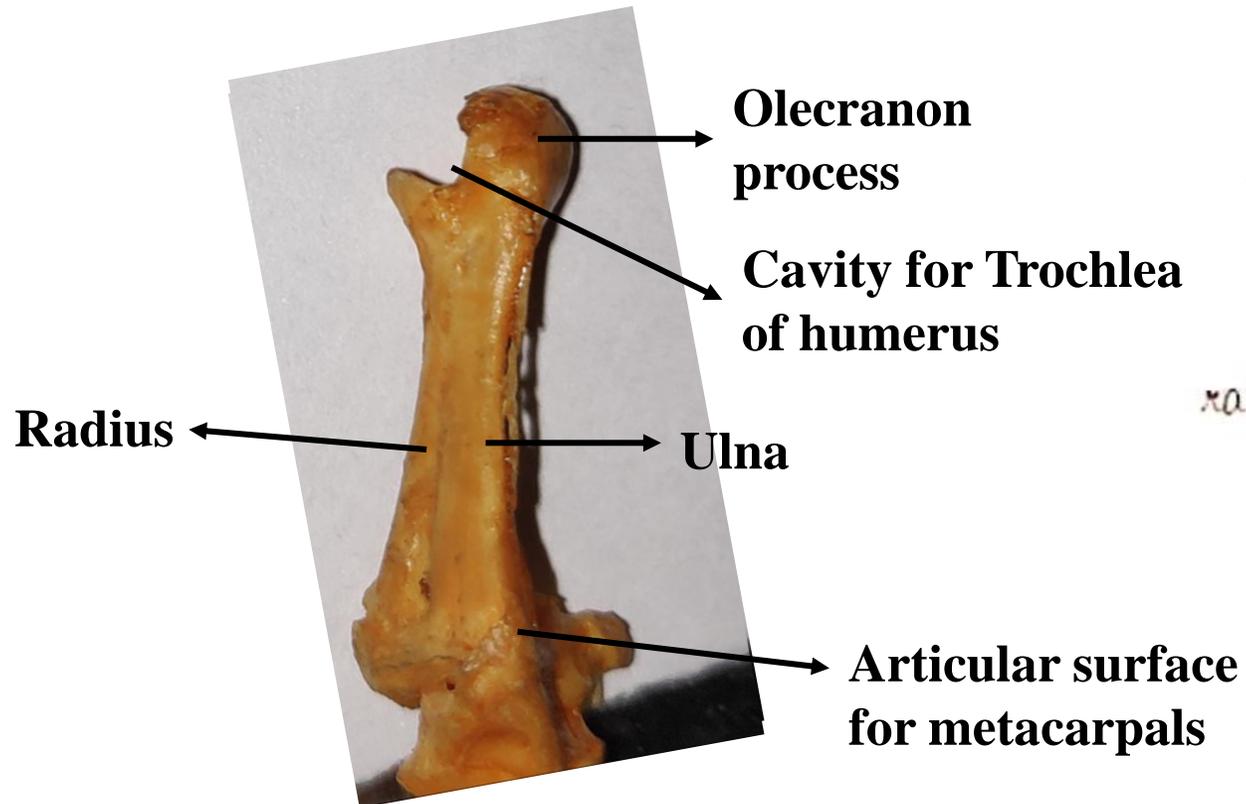
ANTERIOR VIEW



POSTERIOR VIEW

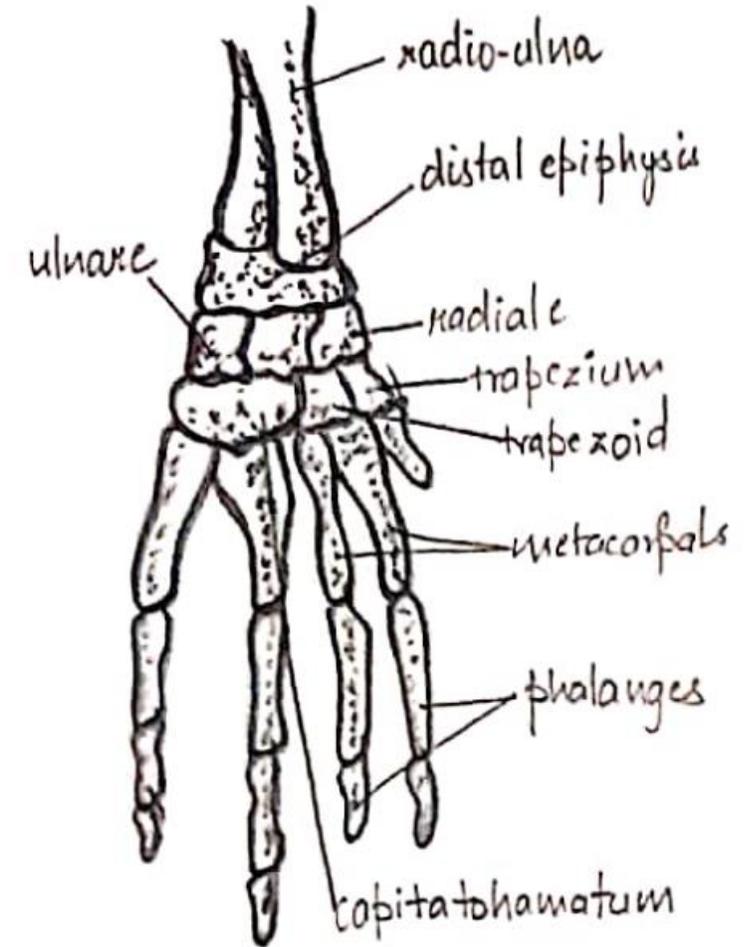
2. RADIO-ULNA

- Compound bone of forearm formed by fusion of radius and ulna.
- Proximal end contains a **concavity** for articulation with capitulum of humerus and an **olecranon process**.
- A groove divides radius and ulna distally: each terminates into a facet to articulate with **carpal** bones.

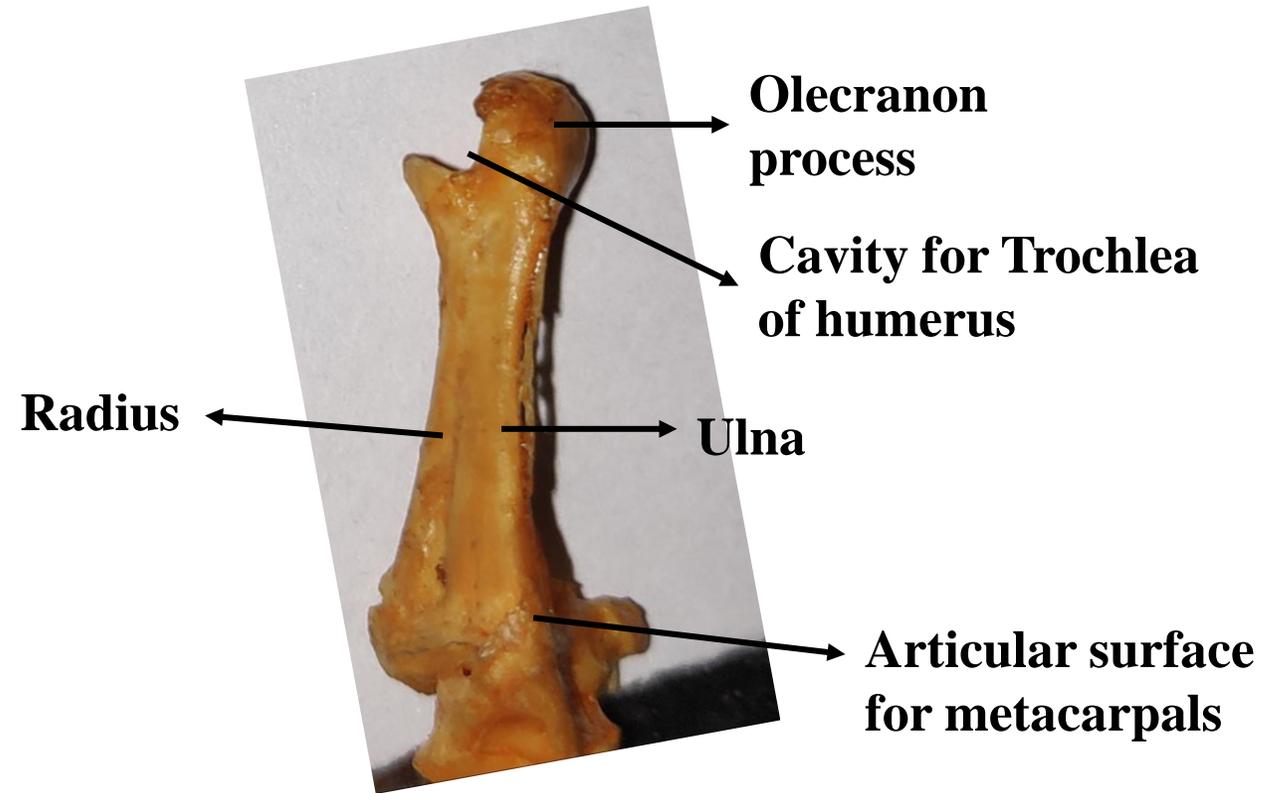
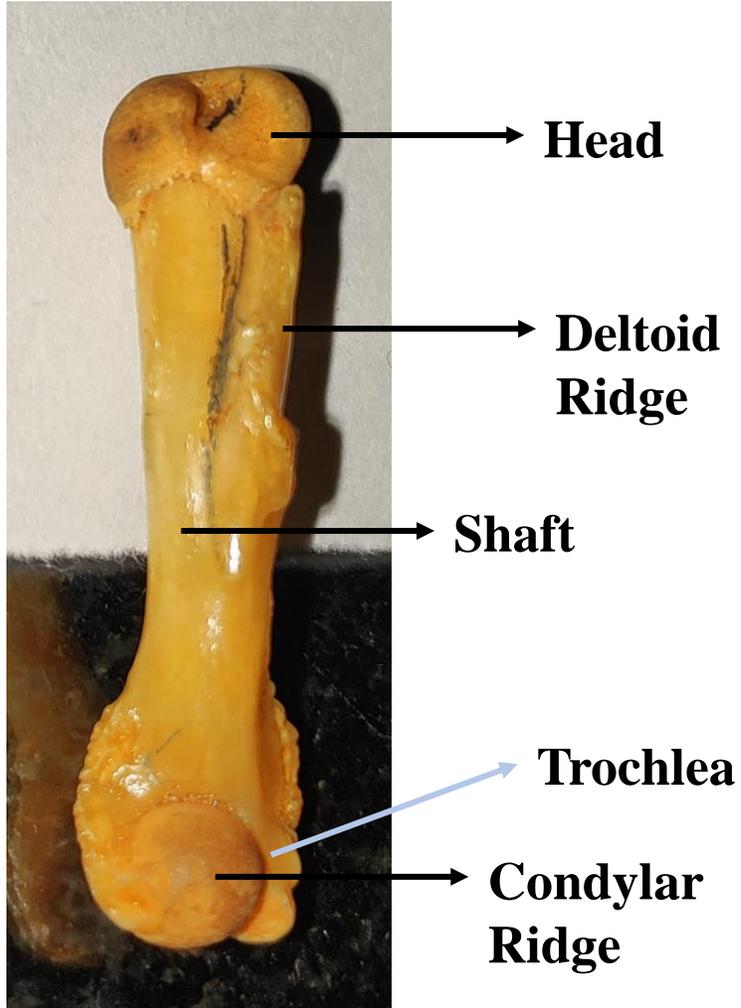


3. BONES OF HAND

- **Wrist Bones:** Carpals. 6 in number and arranged in two rows of three each.
- Bones of proximal row: **RADIALE, INTERMEDIUM, ULNARE**. Articulate with the radio-ulna
- Bones of Distal Row: **TRAPEZIUM, TRAPEZOID and CAPITOHAMATUM** articulate with metacarpals.
- First metacarpal is rudimentary and without a digit and phalanges.
- Digits are internally supported by short bony rods: **phalanges**.
- First and second digits contain two phalanges each, third and fourth digits have 3 phalanges each.
- Claws are absent.



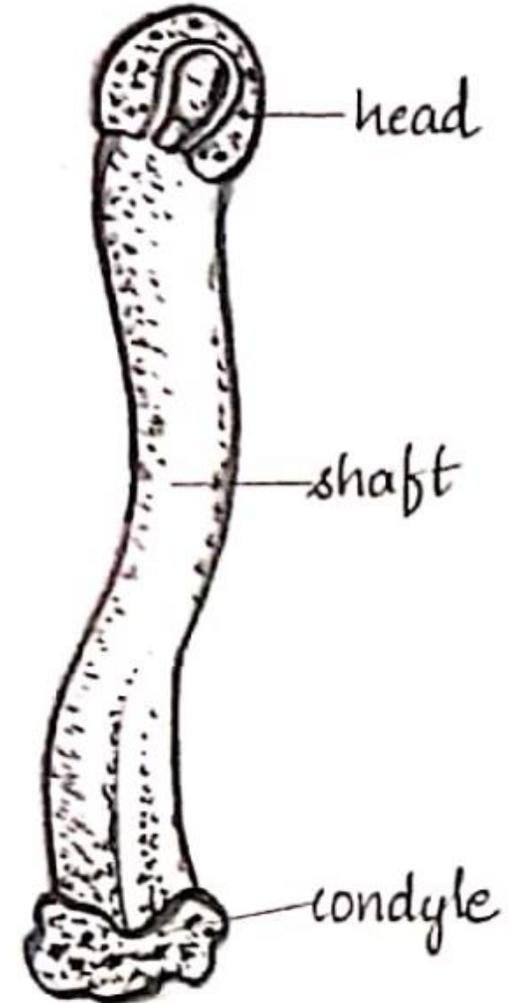
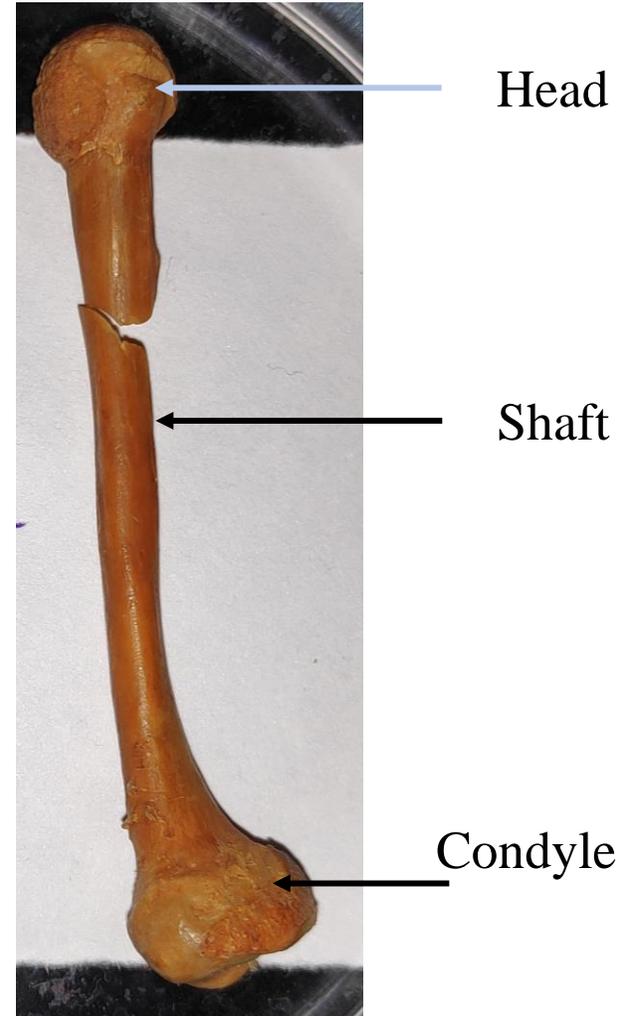
Fore Limbs



FROG: HIND LIMBS

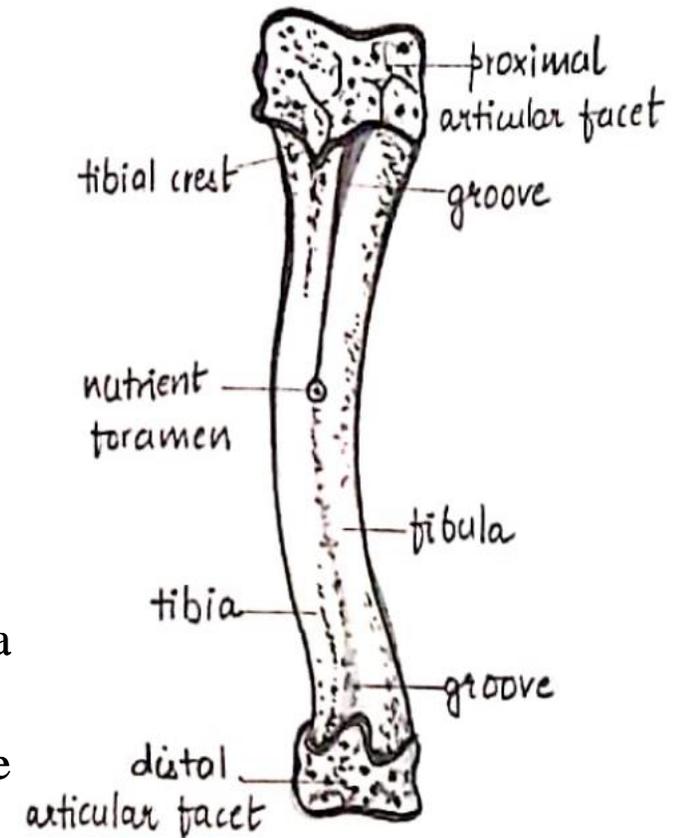
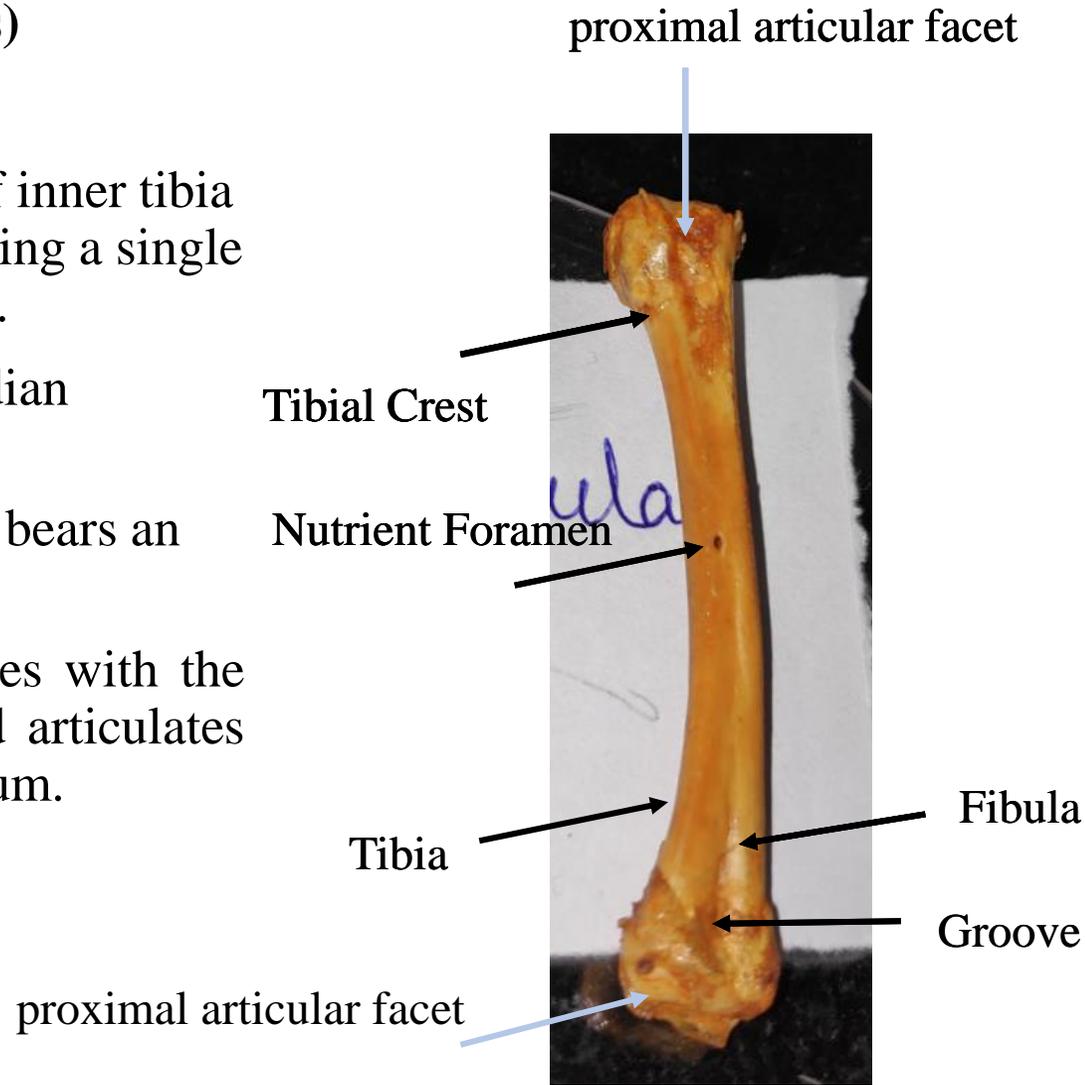
1. Femur:

- It is long and slender having a slightly curved shaft.
- The proximal swollen end is called the head. Head fits into the acetabulum of pelvic girdle forming a ball and socket joint.
- The distal end forms a condyle which articulates with the tibio-fibula.
- Both proximal and distal ends have calcified cartilage.



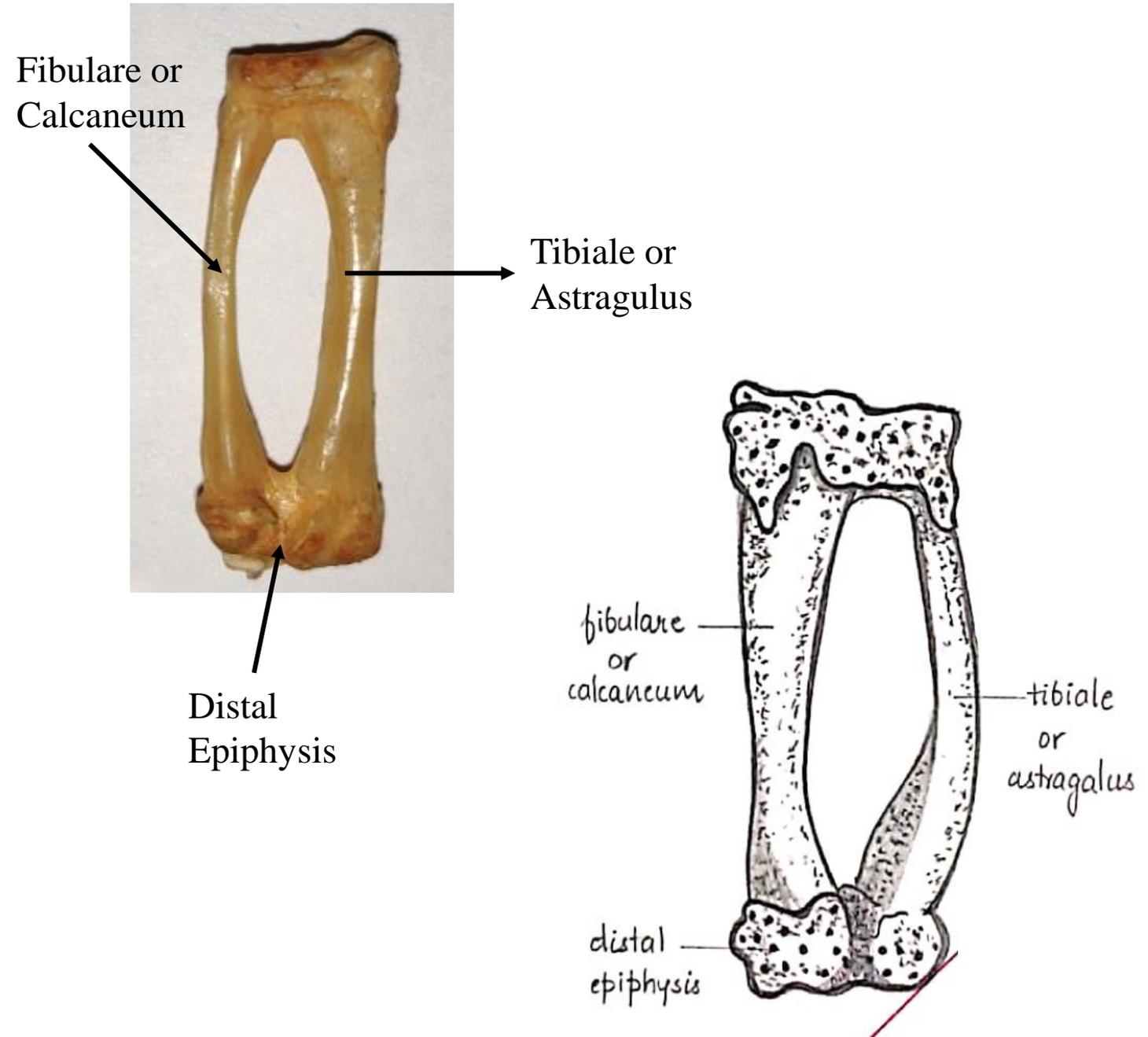
2. Tibio-fibula (Shank bones)

- It is formed by the fusion of inner tibia and outer fibula bones forming a single bone called the tibio- fibula.
- In between the two is a median longitudinal groove.
- Near the proximal end tibia bears an cnemial or tibial crest.
- The proximal end articulates with the femur, while the distal end articulates with the astragalus-calcaneum.

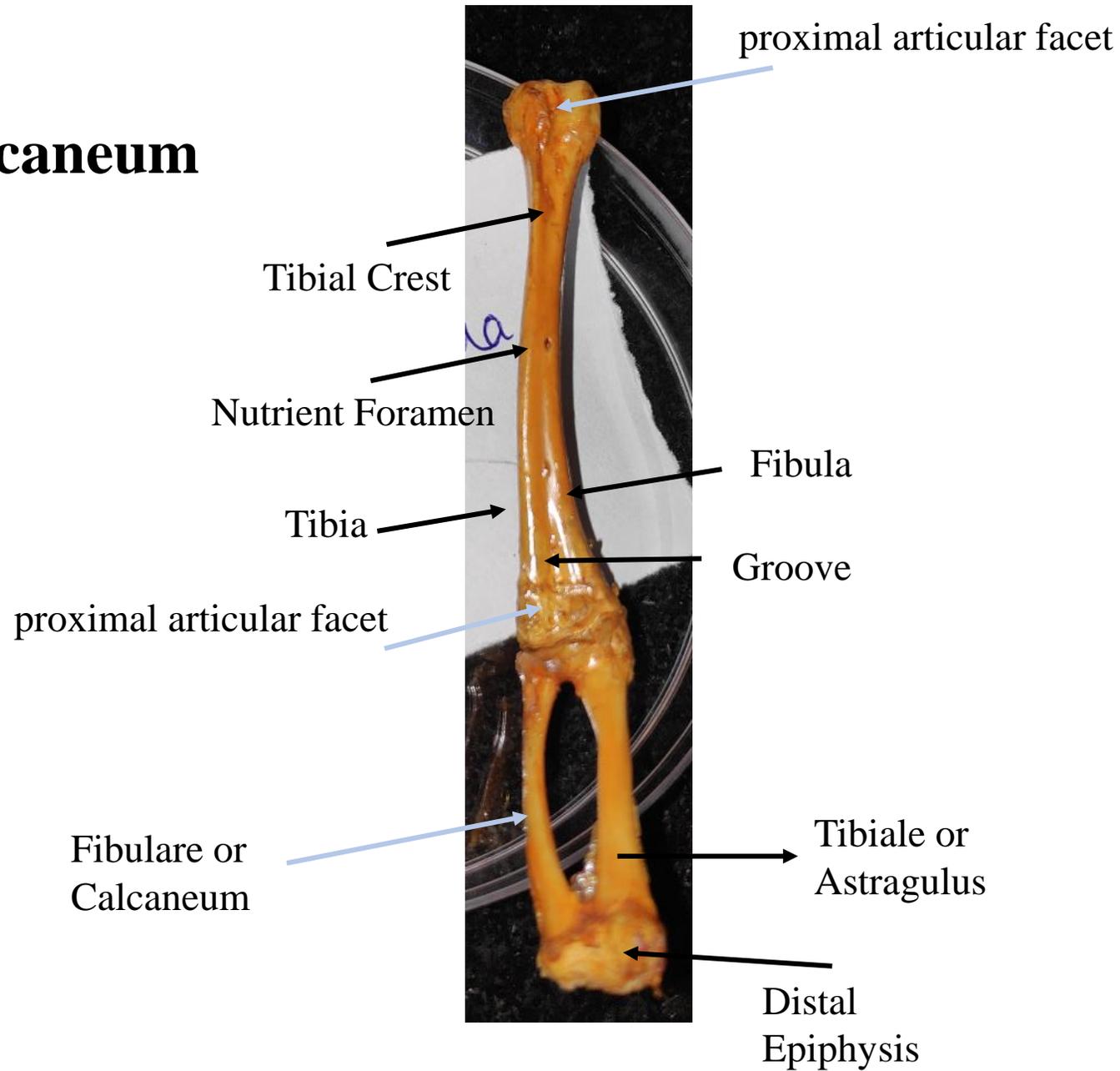


3. Astragalus-Calcaneum

- Proximal ankle bones united at both ends and covered by proximal and distal epiphyses of calcified cartilages.
- The ankle consists of two rows of four tarsal bones. The proximal row consists of two long bones fused together at their proximal and distal ends with a wide gap in the middle.
- The inner bone is thinner and slightly curved, called the **astragalus or tibiale**, while the outer bone is thicker and straight, called the **calcaneum or fibulare**.
- Distal row of tarsals has two very small bones.

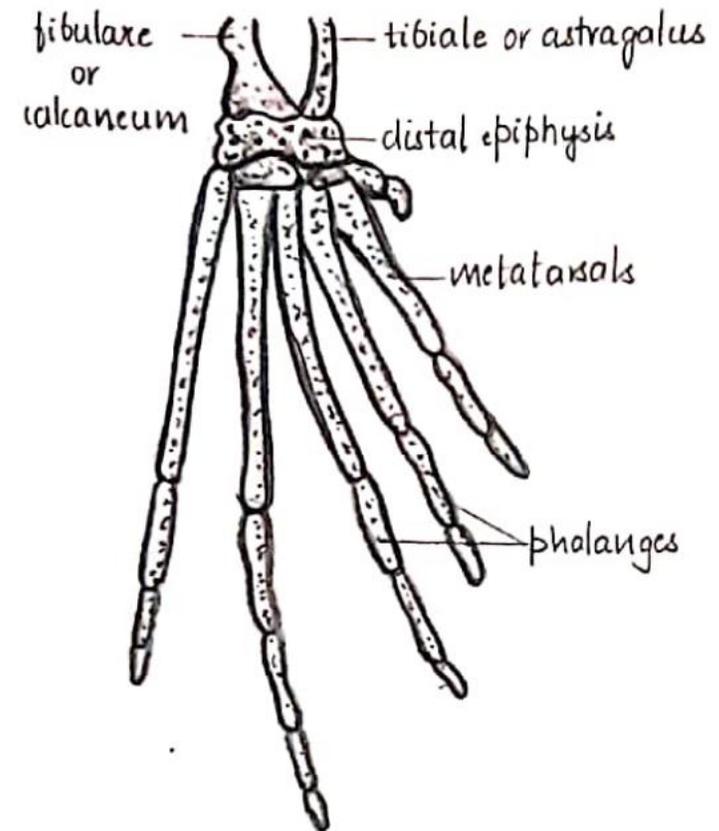
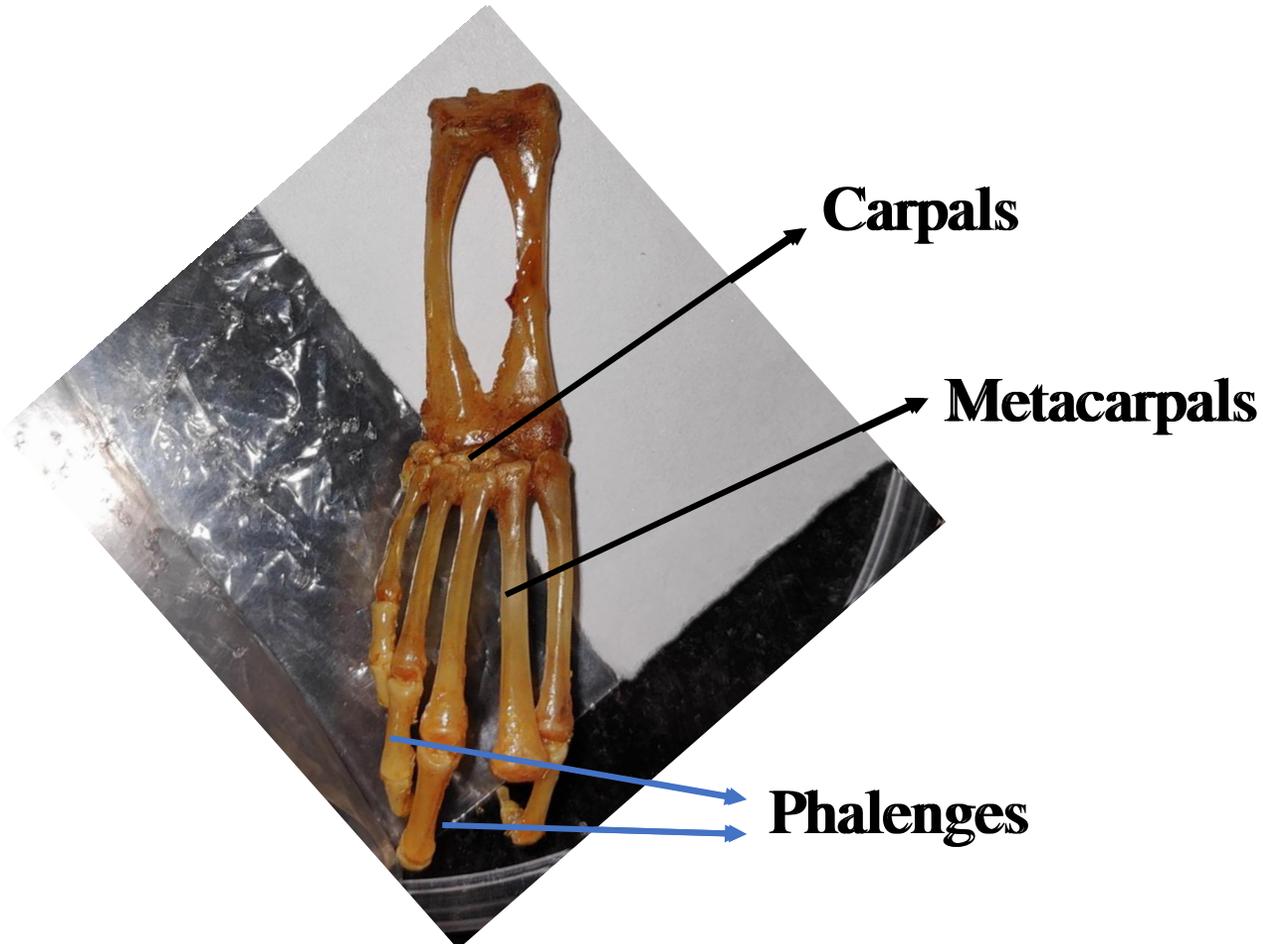


Tibio Fibula & Astragulus Calcaneum

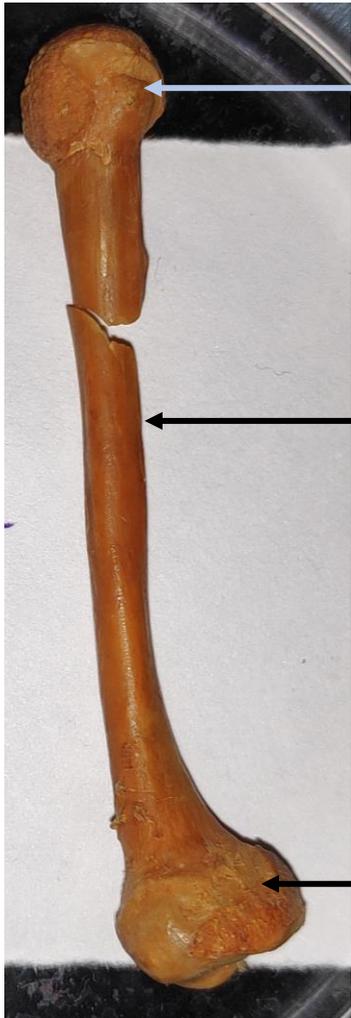


4. Bones of foot

- The foot or pes is supported by five long and slender metatarsals bearing five true toes, having 2, 2, 3, 4 and 3 phalanges respectively.
- Preaxial sixth toe is called the prehallux or calcar and does not project from the toe.



Hind Limbs



Head

Shaft

Condyle

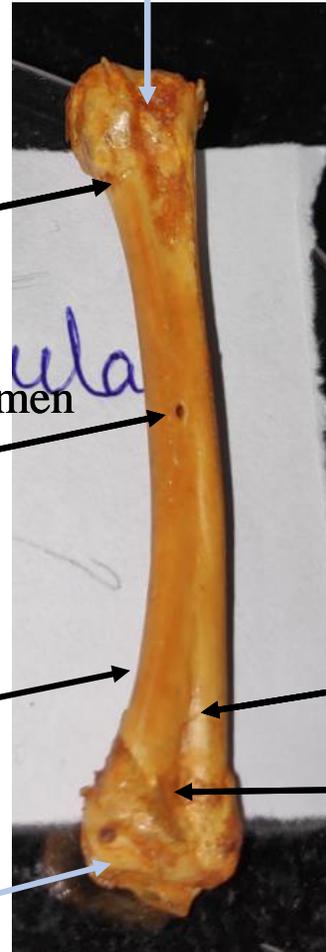
proximal articular facet

Tibial Crest

Nutrient Foramen

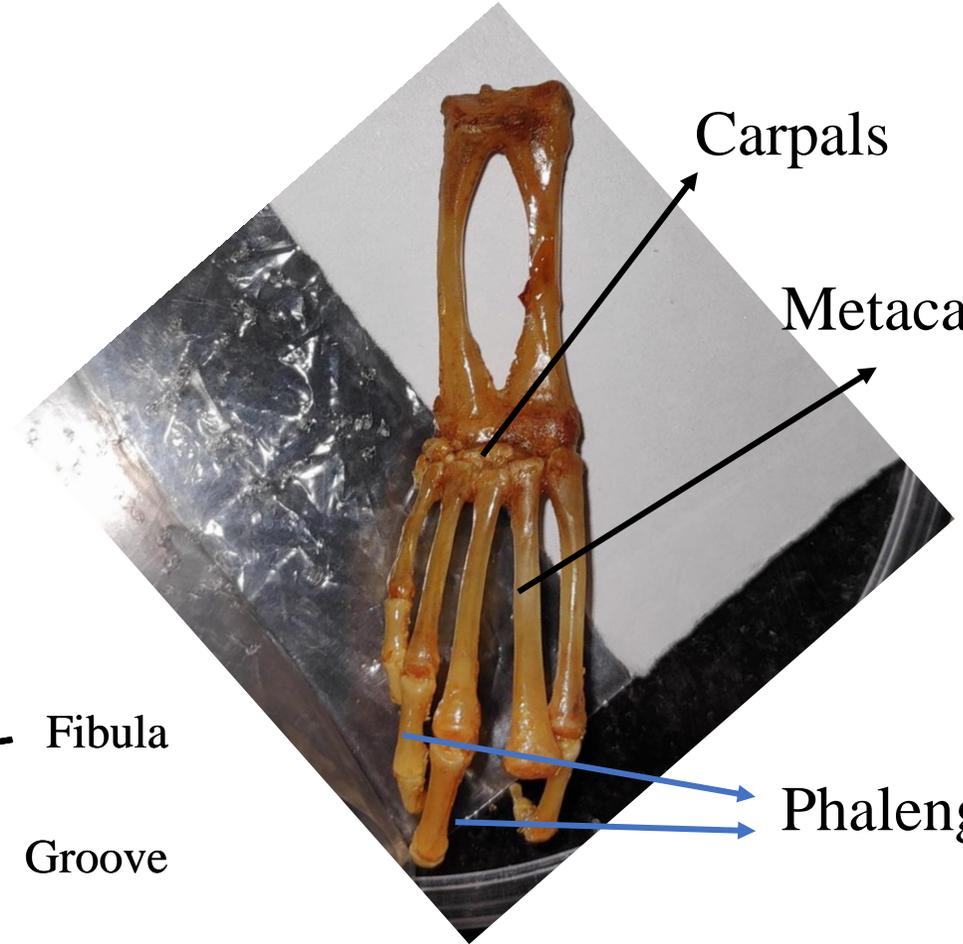
Tibia

proximal articular facet



Fibula

Groove



Carpals

Metacarpals

Phalanges