



# Birds

Alicia Grosso, M.S.



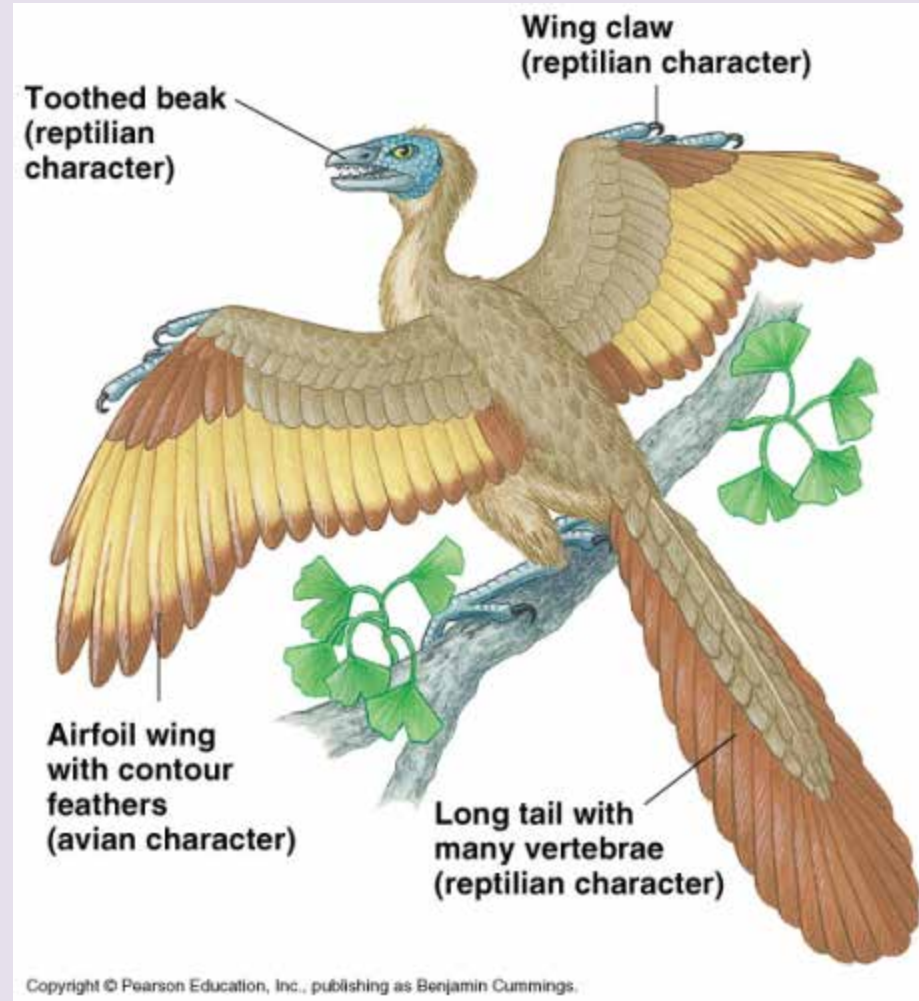


# Bird Characteristics

- Feathers—unique to birds (and dinosaurs)
- Endothermic (internal heat generation)
- Flight
- Breathing—with lungs and associated air sacs
- Internal fertilization and a hard-shelled amniotic egg

# Bird Evolution

- The oldest known bird fossil? *Archaeopteryx lithographica* (bird and reptile).
  - Jurassic period (~150 mya)
- Reptilian features:
  - Long tail, teeth, long clawed fingers
- Avian features:
  - Feathers, ribs with uncinata processes, and an avian shoulder girdle



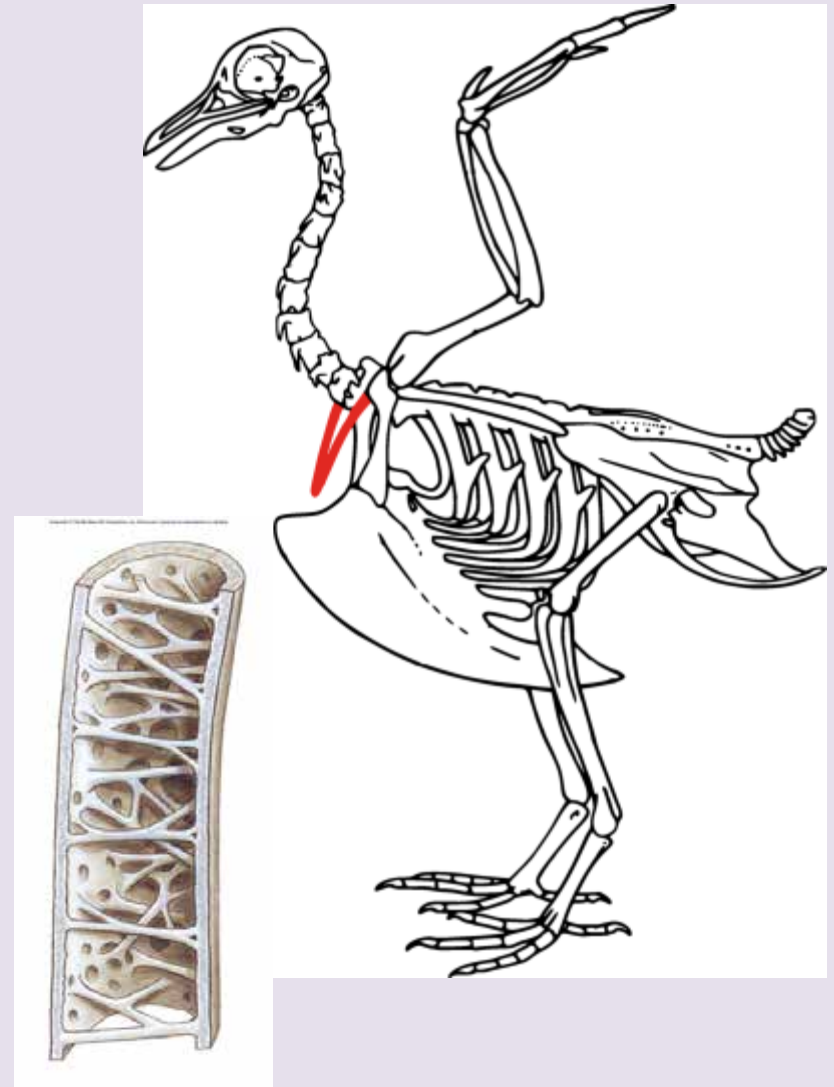
# Evolution of Feathers



- As the reptile line leading to birds became endothermic, the ability to conserve heat (insulation) was selected.
- Longer scales = better insulation (up to a point)
- Also provides lift for flight
- Now, both insulation and lift were selected for and feathers, wings, etc. evolved (along with out other theories of the evolution of flight).
- Today, over 9,500 species of birds (compared to about 4,000 mammals).

# Specializations for Flight

- Large flight muscles
- Rigid skeleton
  - Fused bones
  - Ex. Furcula
- Efficient respiration
- Reduced mass
  - Hollow bones supported by internal struts of spongy bone (Except flightless birds like penguin and ostrich)
  - No teeth
  - Wrist bones reduced to 2
  - Reptilian tail lost



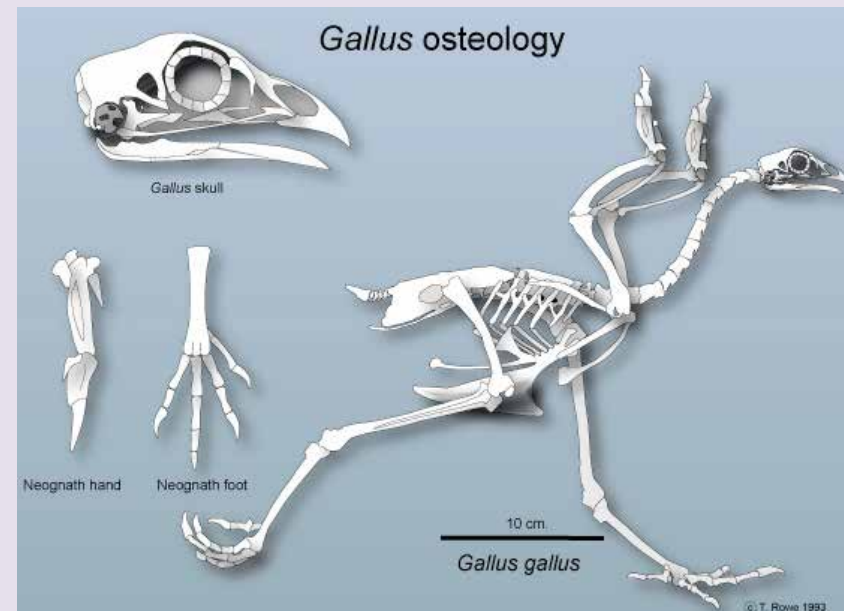


# Birds to Compare

- Turkey: *Meleagris gallopavo*
- Chicken: *Gallus gallus*
- Canada Goose: *Branta canadensis*
- Mallard Duck: *Anas platyrhynchos*
- Great Horned Owl: *Bubo virginianus*
- Barred Owl: *Strix varia*
  - Different owls only compared for Crania
- Red-Tailed Hawk: *Buteo jamaicensis*
- American Crow: *Corvus brachyrhynchos*
- Blue Jay: *Cyanocitta cristata*
- Pigeon: *Columba livia*

# Comparing Birds

- Grouping birds helps with comparison
  - Turkey & chicken
    - Ground; longer legs than wings
  - Goose & duck
    - Water/flight; longer wings than legs
  - Owl(s) & hawk
    - Birds of prey
  - Blue jay & crow
    - Same family (*Corvidae*)
  - Pigeon
    - Oddball



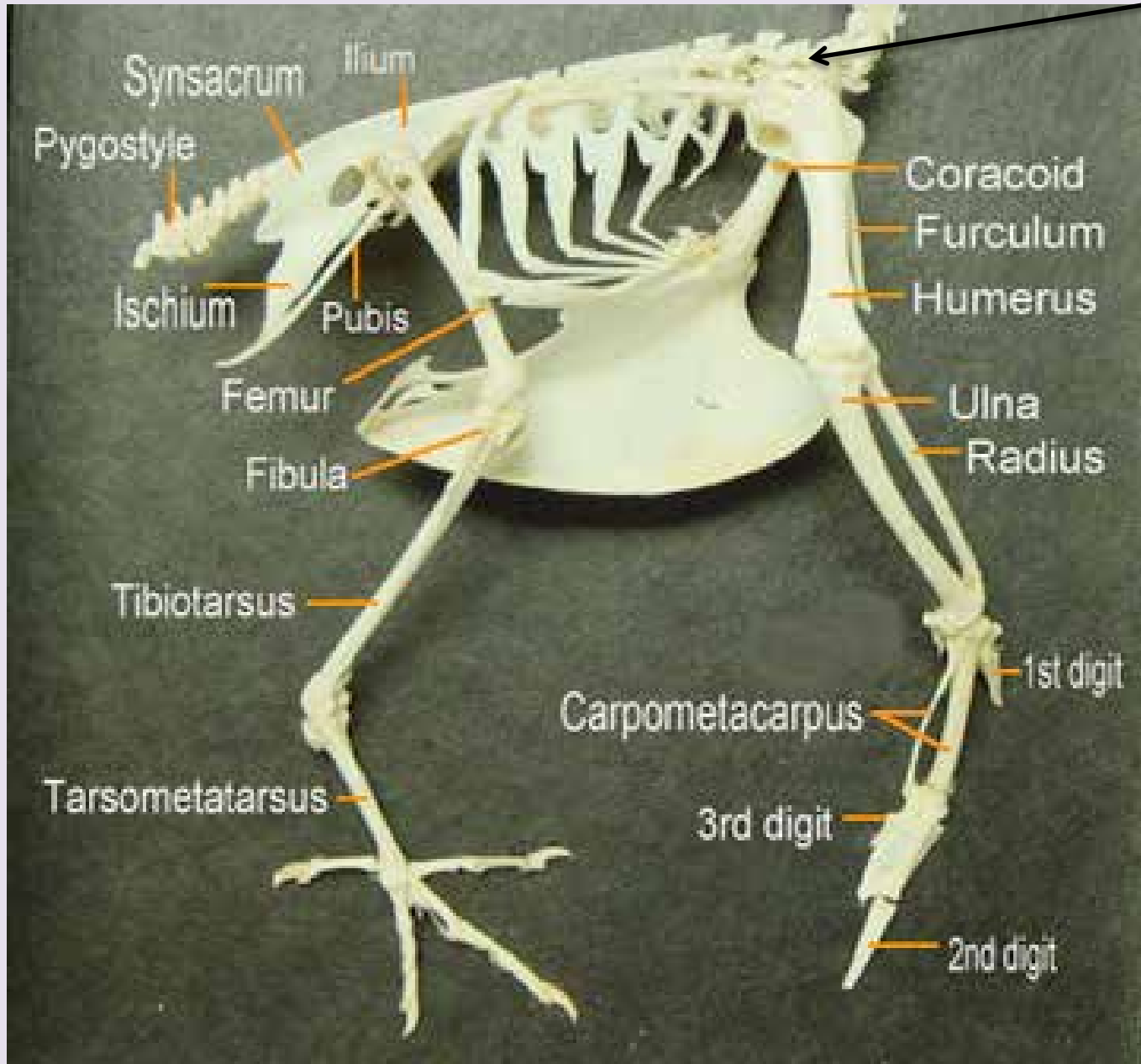
- Bones NOT drawn to scale
- Jargon kept to a minimum J

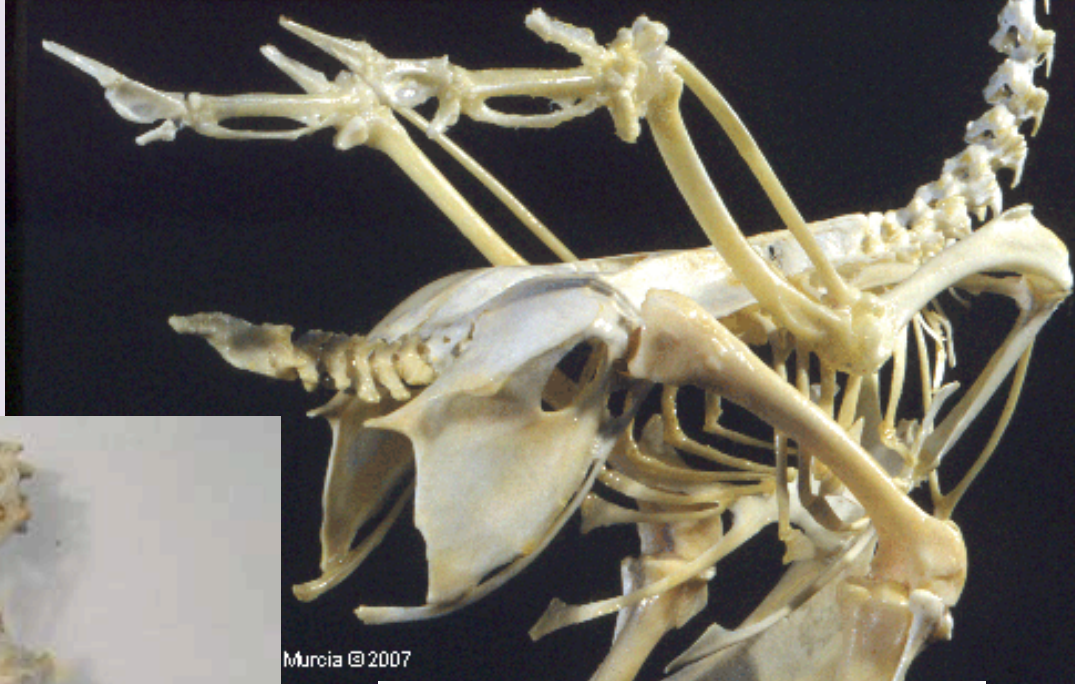
# General Bird Features

- Beaks
- Expanded braincase
- Scleral rings/ossicles in enlarged eye orbits
- Hollow bones
- Shoulder girdle, forelimb, and sternal keel reflect required movements for flight
- Uncinate processes on ribs
- Reduced tails

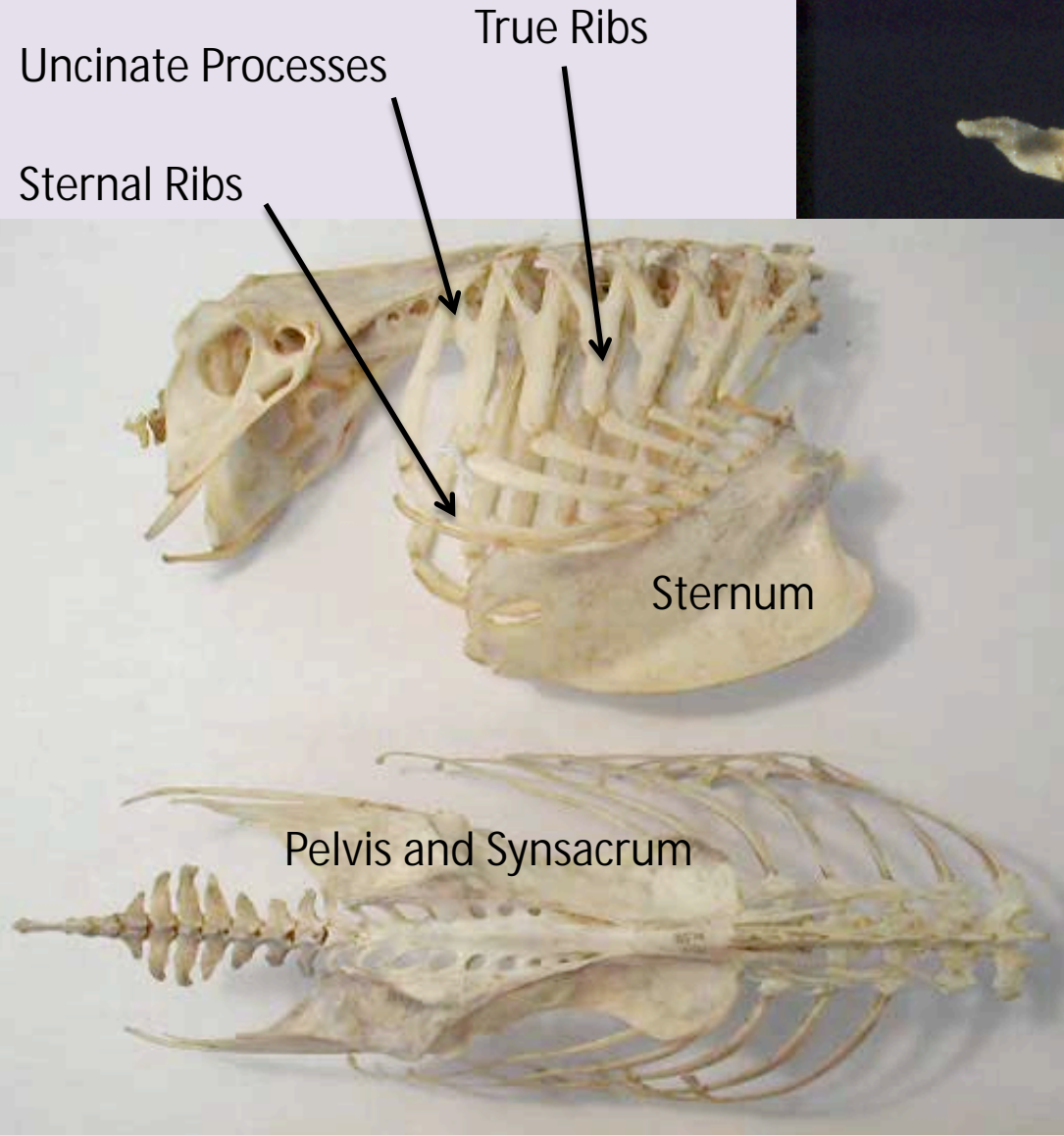


Notarium





Murcia © 2007



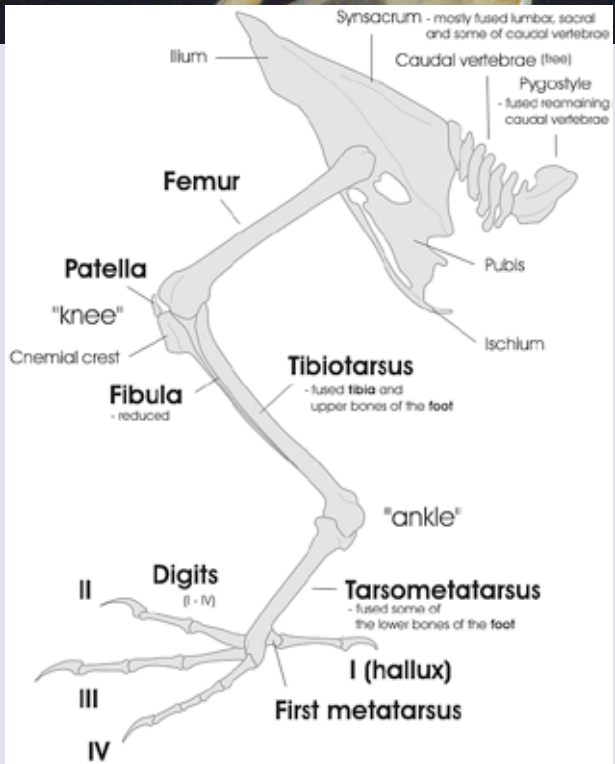
True Ribs

Uncinate Processes

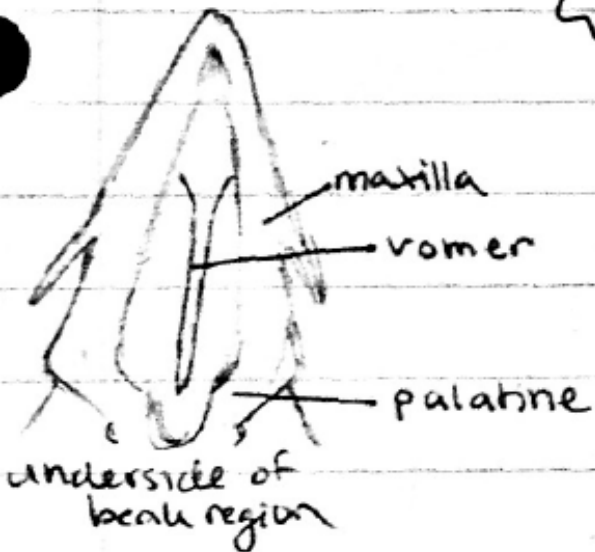
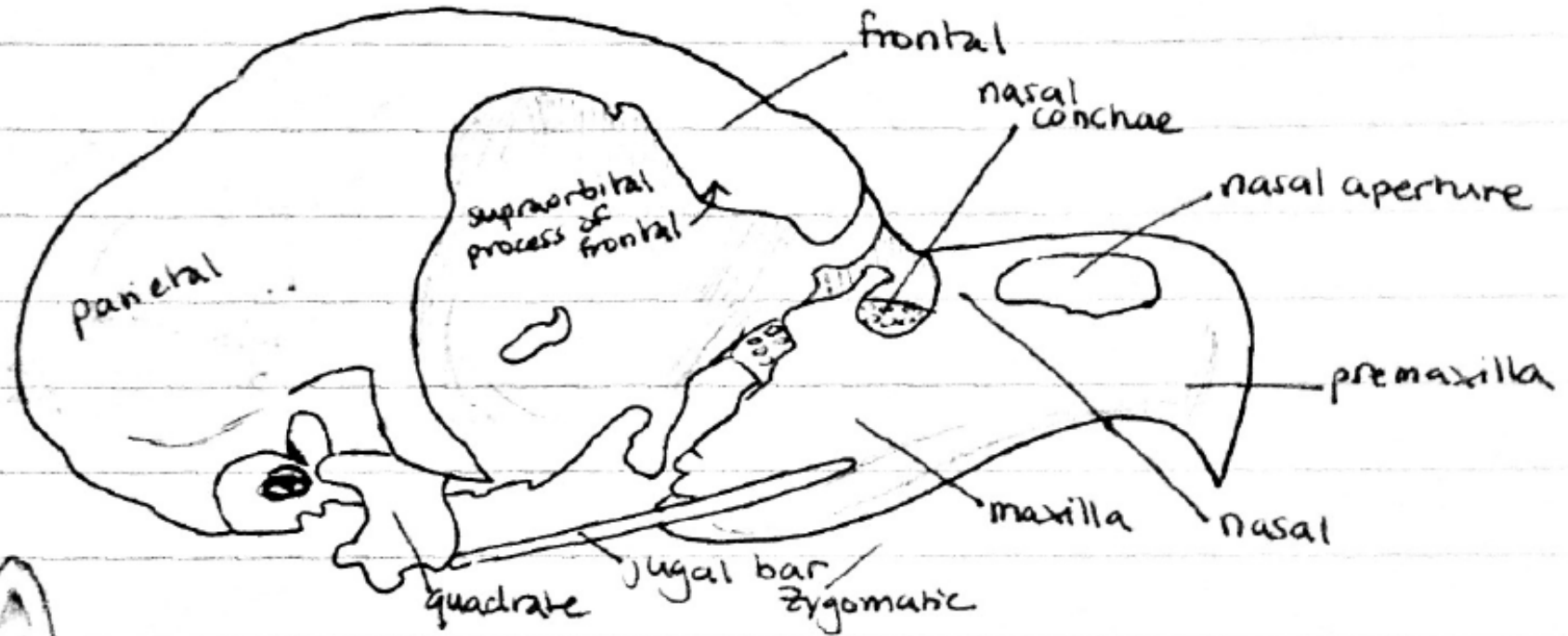
Sternal Ribs

Sternum

Pelvis and Synsacrum



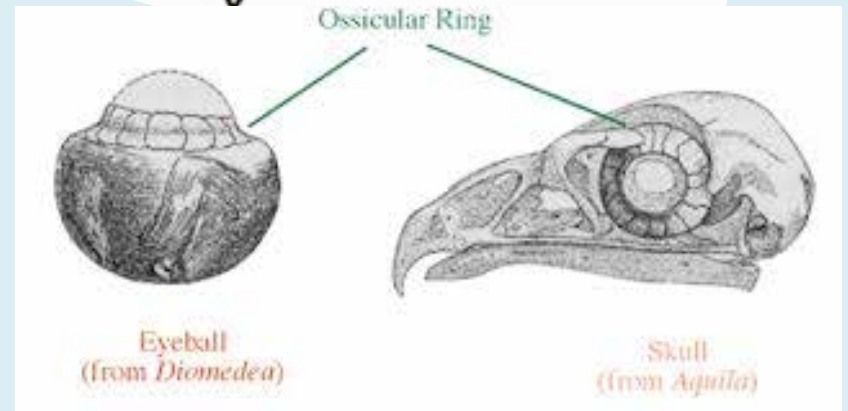
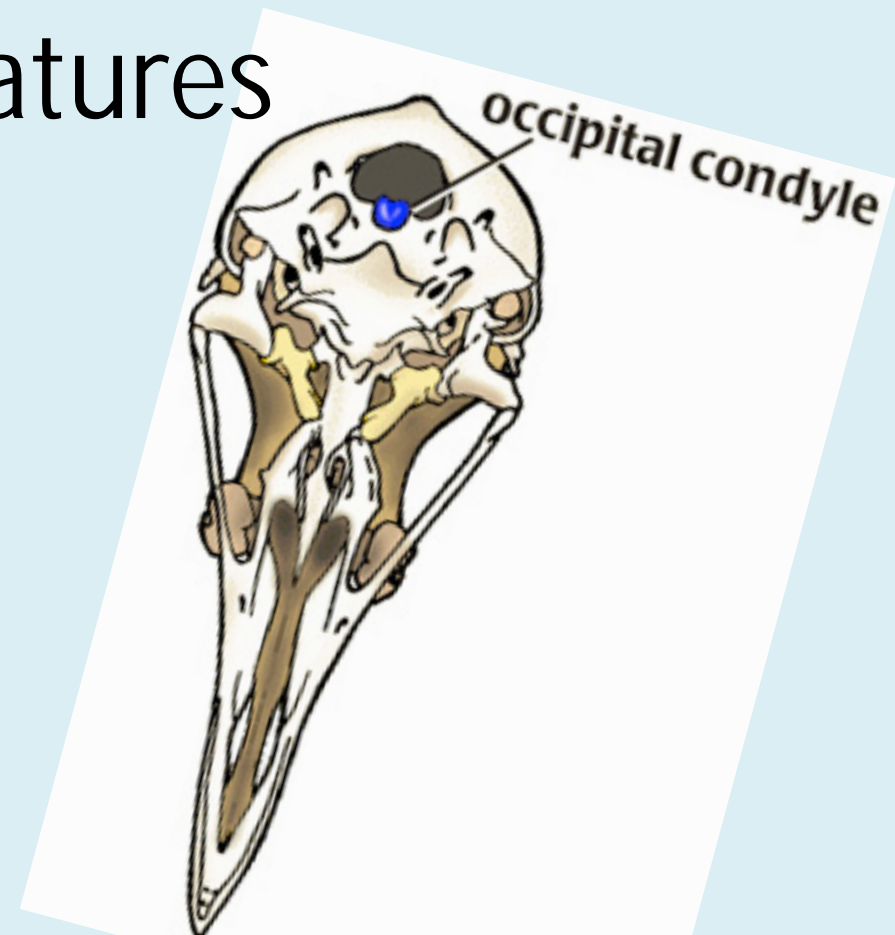
# General Cranium



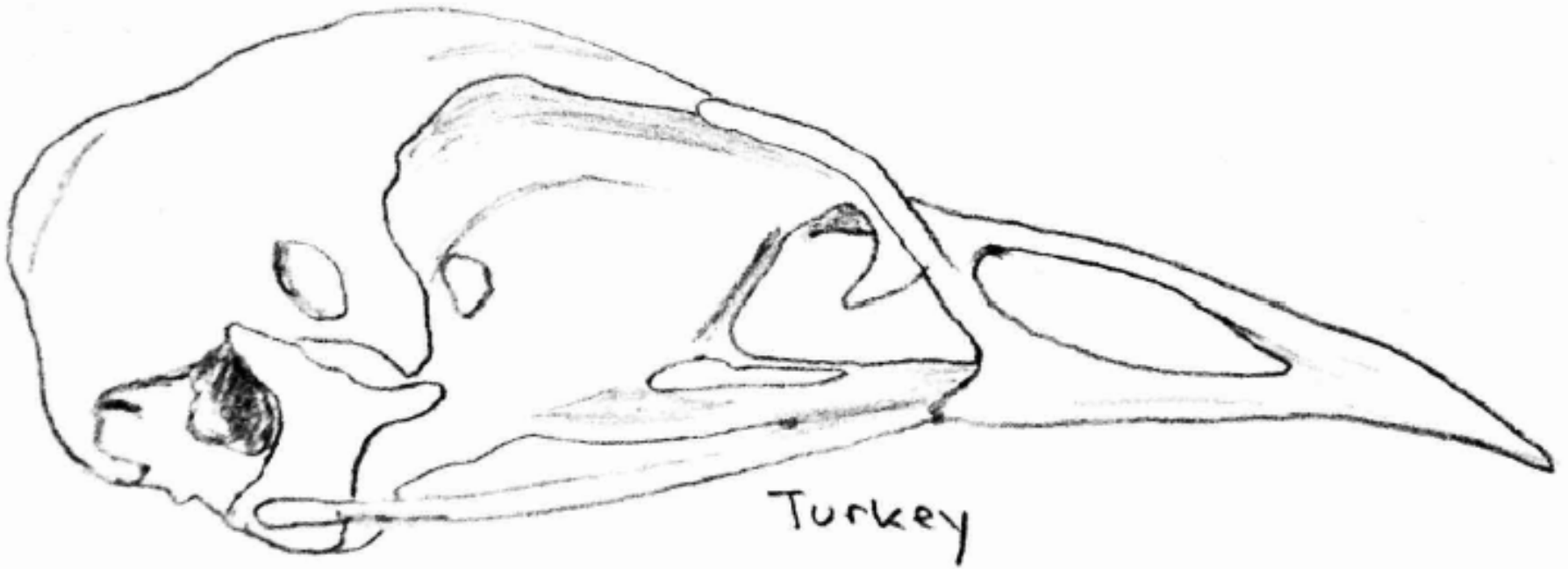
[diving birds such as gulls, grebes, loons, + penguins are not pneumatized — compromise between flight and submerged swimming].

# Skull Features

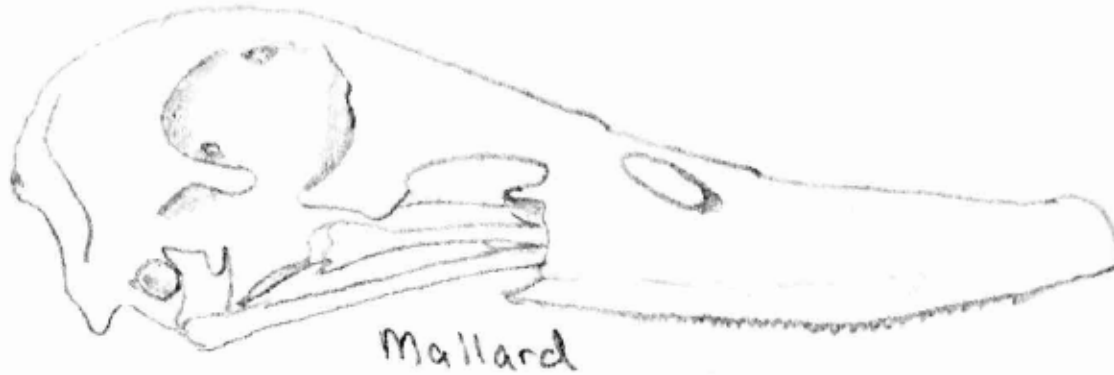
- Modified diapsid
- 1 occipital condyle
- 1 middle ear bone
- Bony sclerotic ring in eye
- Mandible composed of several bones



# Crania: Turkey & Chicken

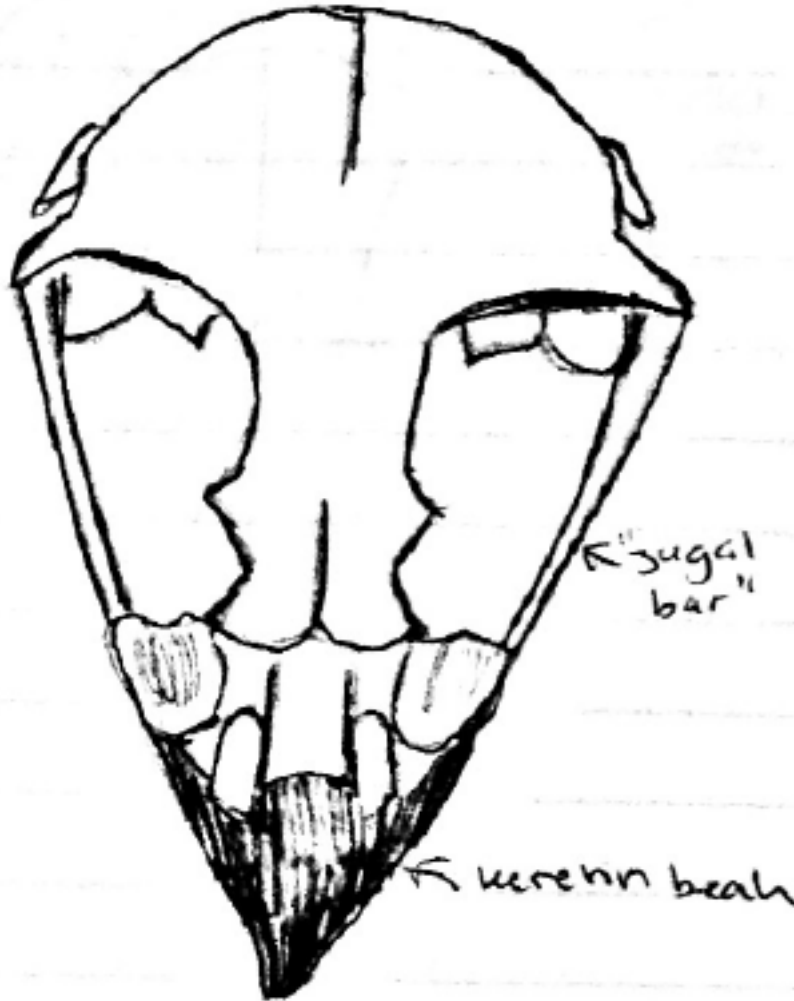


# Crania: Duck & Goose



# Crania: Owls

Great Horned owl

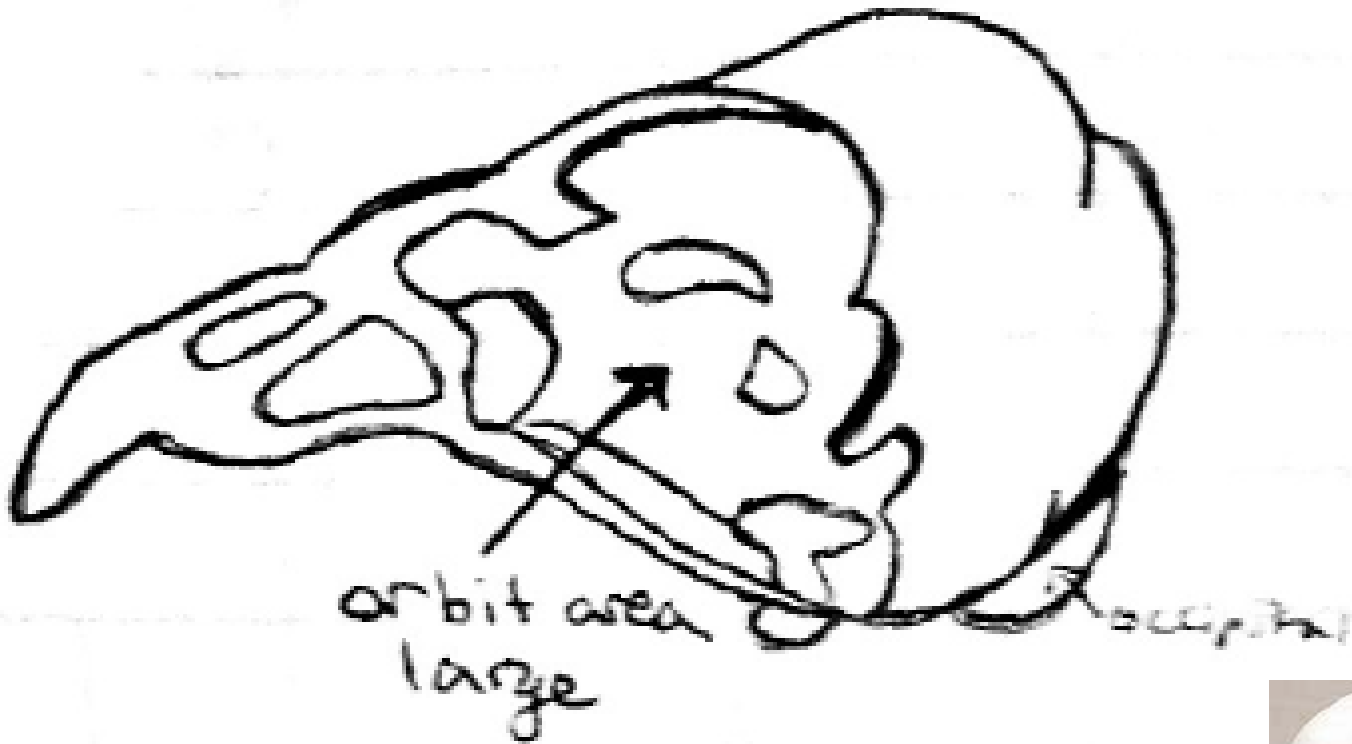


Barned owl



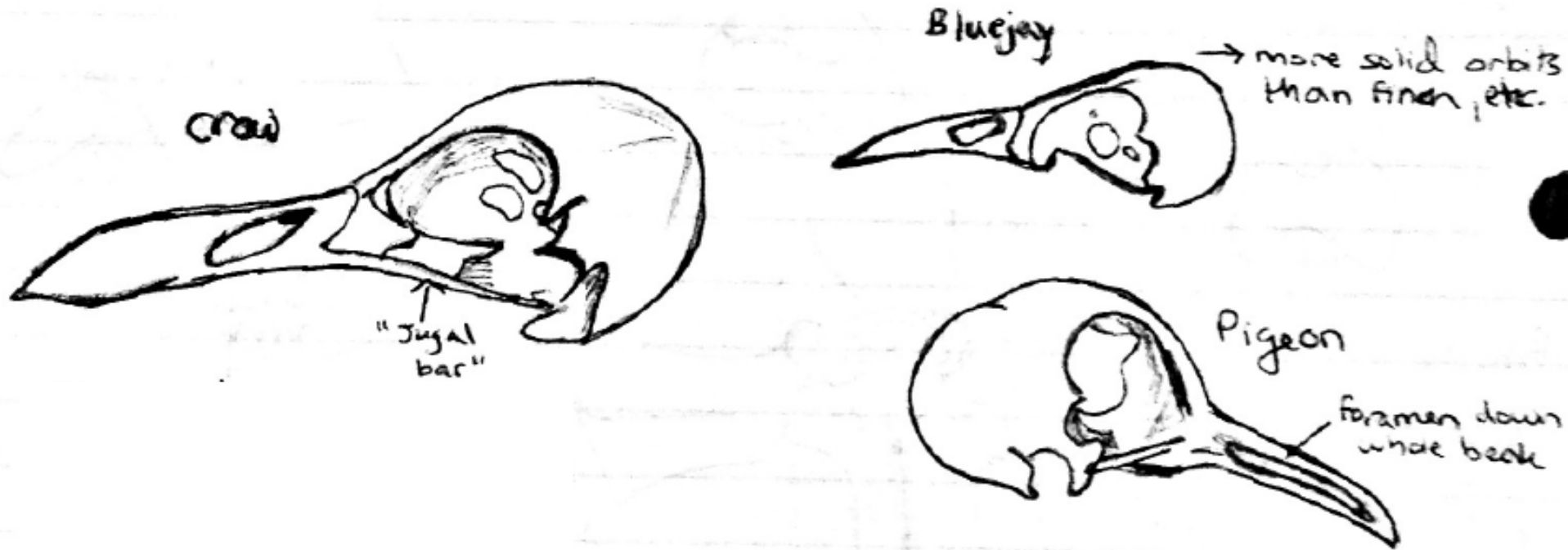
# Cranium: Hawk

Hawk





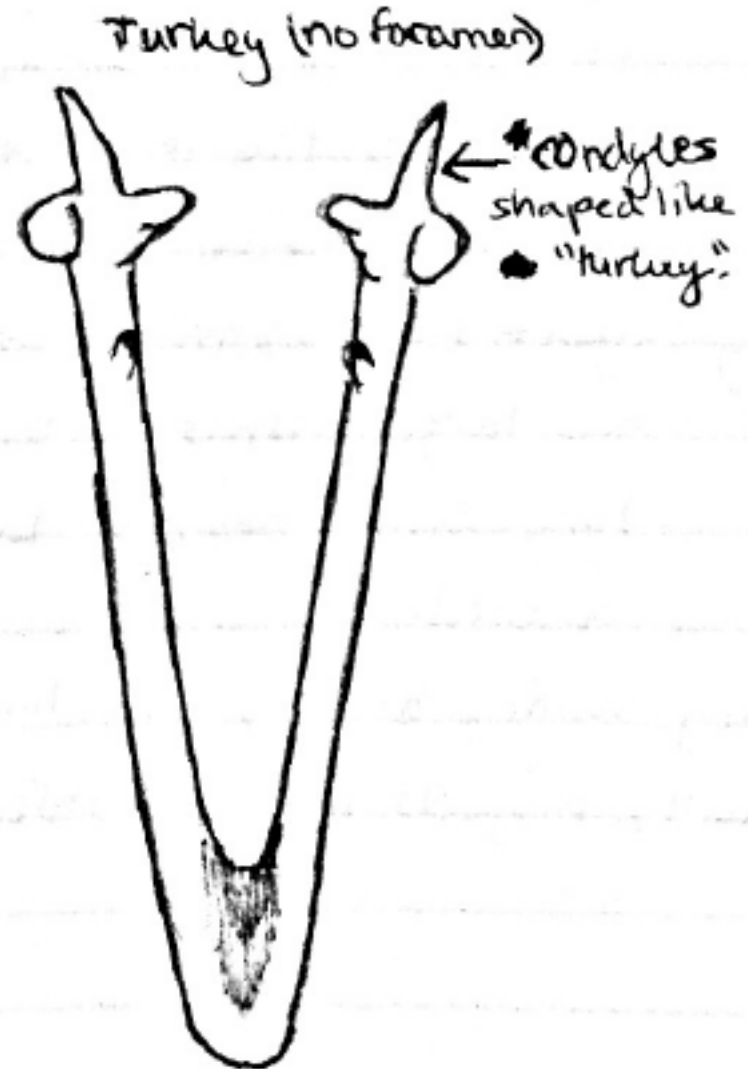
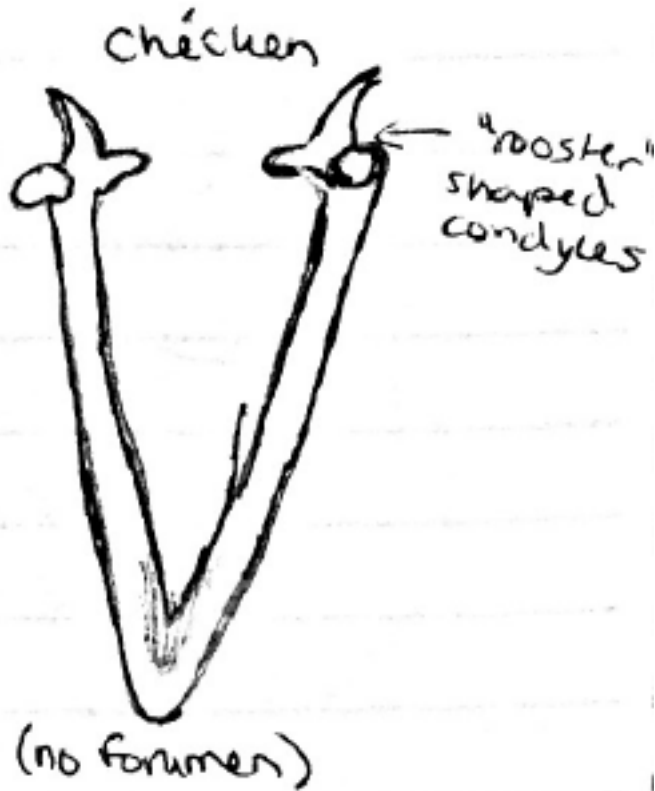
# Crania: Crow, Blue Jay, Pigeon



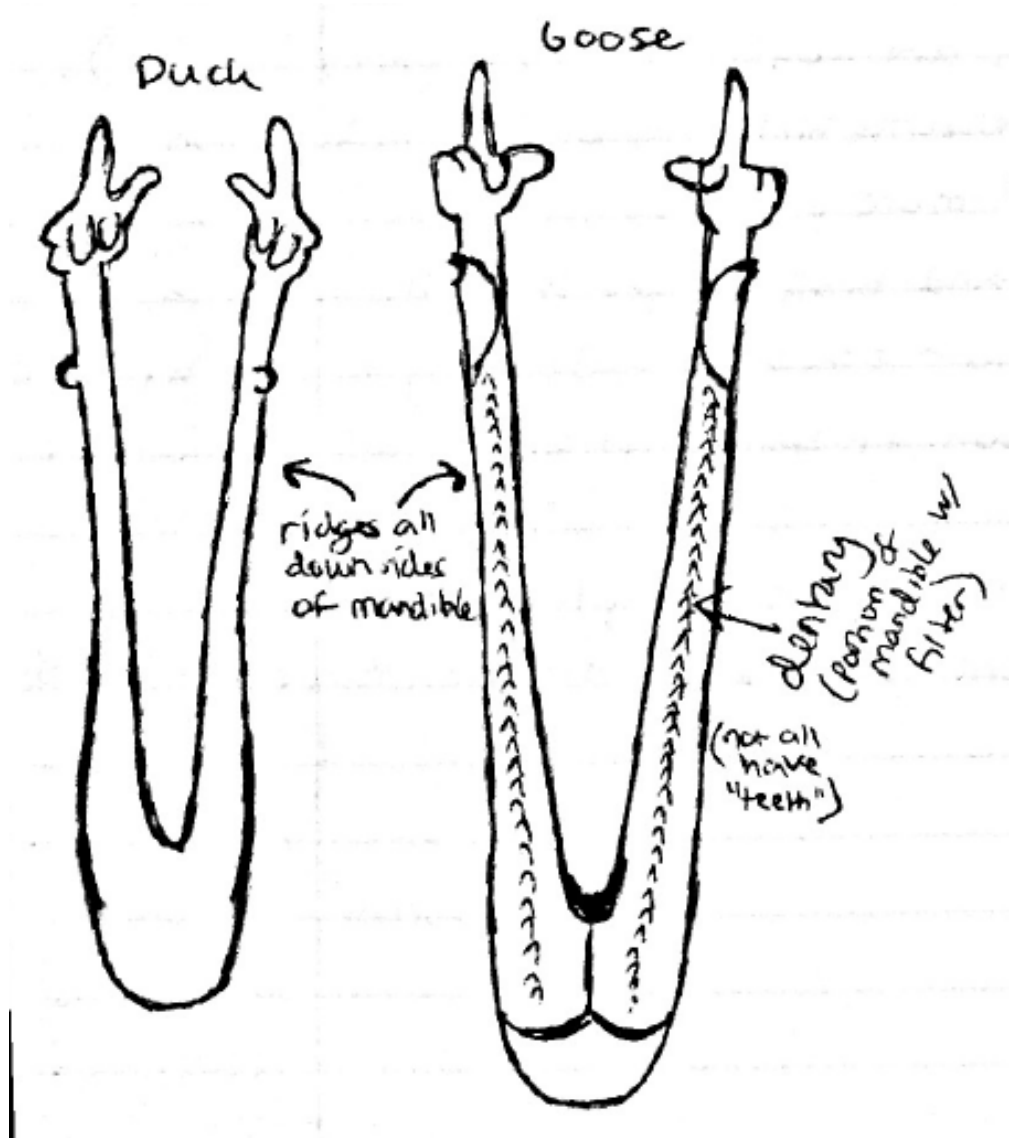
# Cranium Notes

- **Turkey/Chicken:** Beaks more pointed, less robust than goose/duck, large open nostrils. Chicken more sleek (turkey larger and larger brain case).
- **Goose/Duck:** Beak just as long as braincase. Duck beak flares out like a paddle (goose tapers). Goose nostrils about  $\frac{1}{2}$  length of beak (duck shorter).
- **Owl/Hawk:** Beaks short and pointed with inferior projection at end (hooked beak in birds of prey). Owls beaks wider (a "larger piece of pie"). Owl has bulging parietal more so than hawk.
- **Crow/Blue Jay:** Golf ball braincase and beak longer than braincase. Beak has large nostrils (crow  $\sim \frac{1}{2}$  beak). Blue Jay has smaller skull, long skinny beak. Longer beaks than are not hooked like owl or a cardinal.
- **Pigeon:** Long skinny, tapering beak with long nostrils almost entire length of beak. Gracile skull, projects a bit inferiorly. Crania smaller than rest of birds.

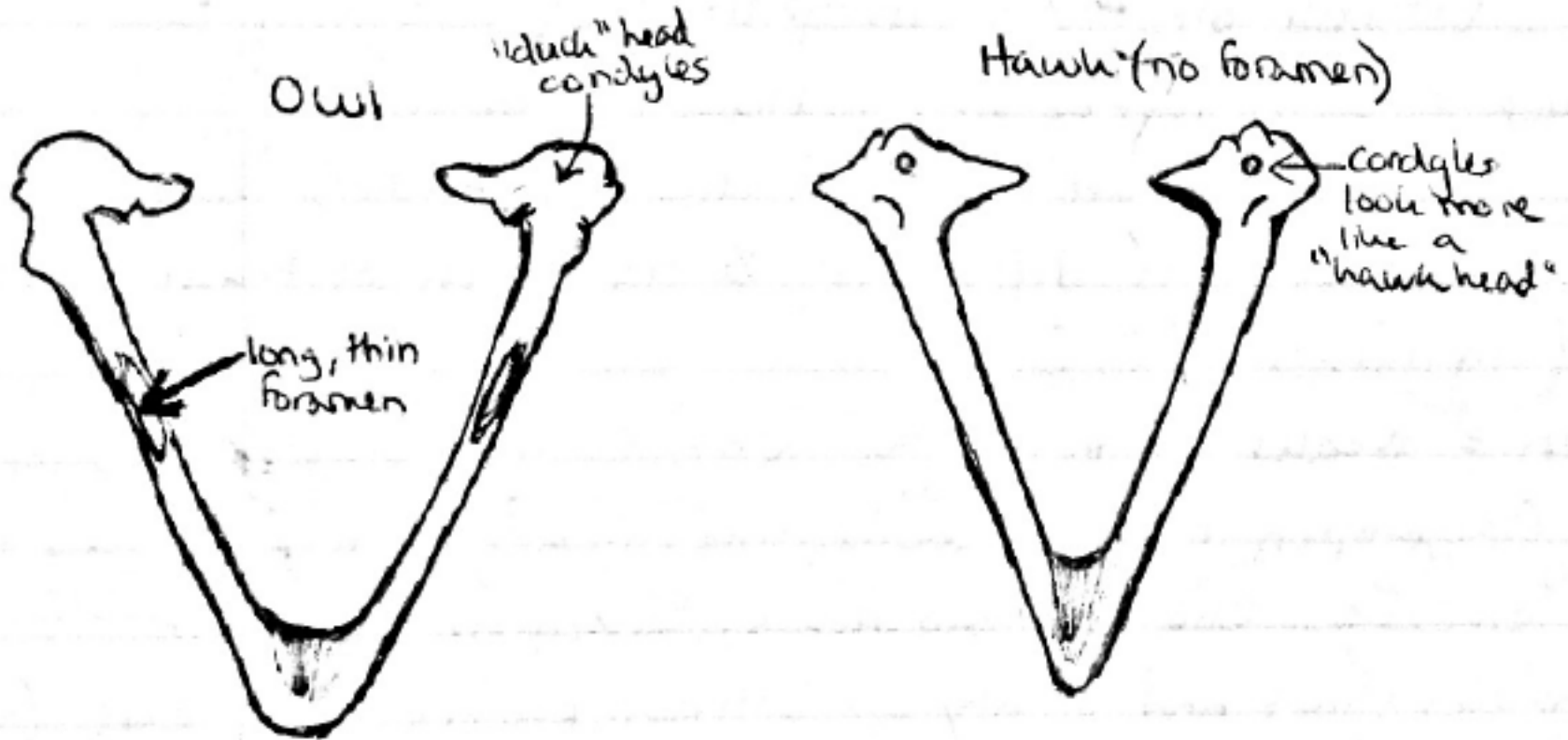
# Mandibles: Turkey & Chicken



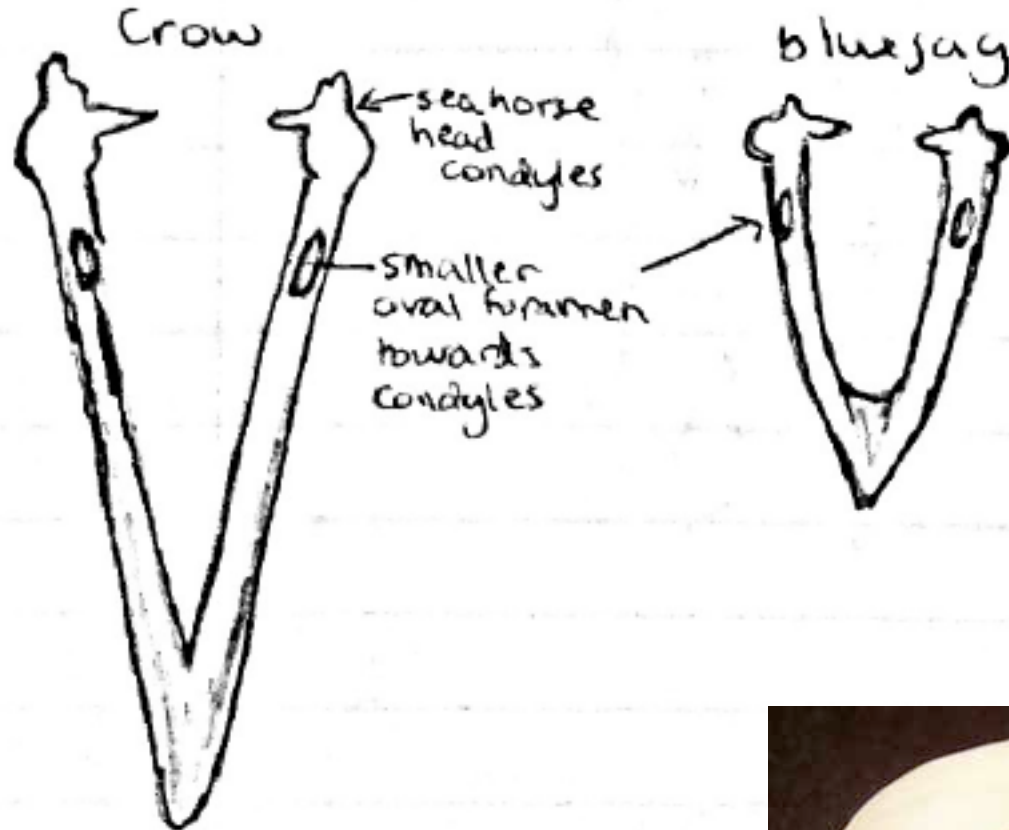
# Mandibles: Duck & Goose



# Mandibles: Owl & Hawk

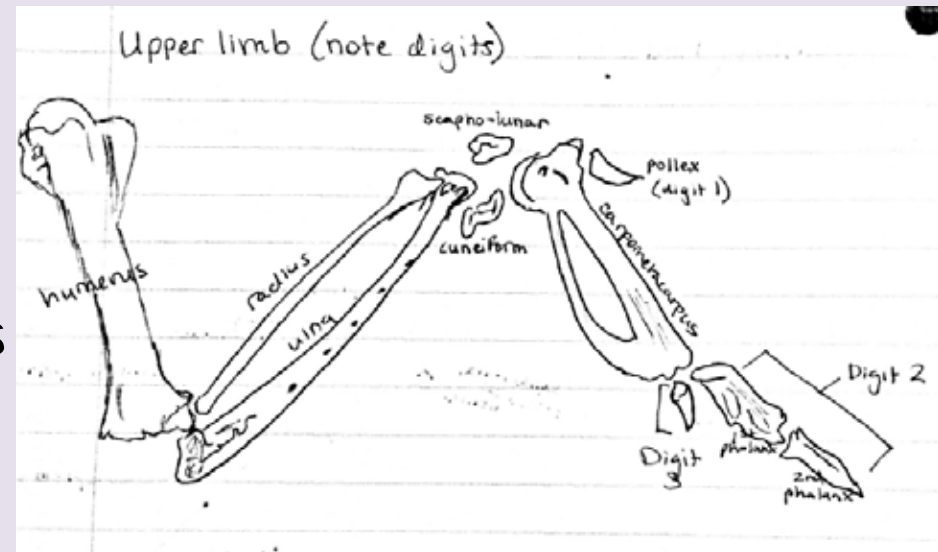
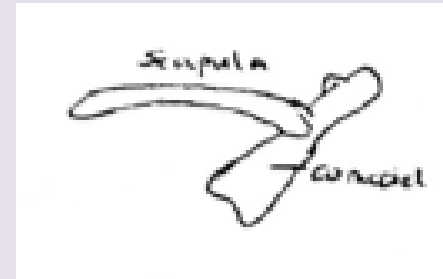


# Mandibles: Crow, Blue Jay, Pigeon

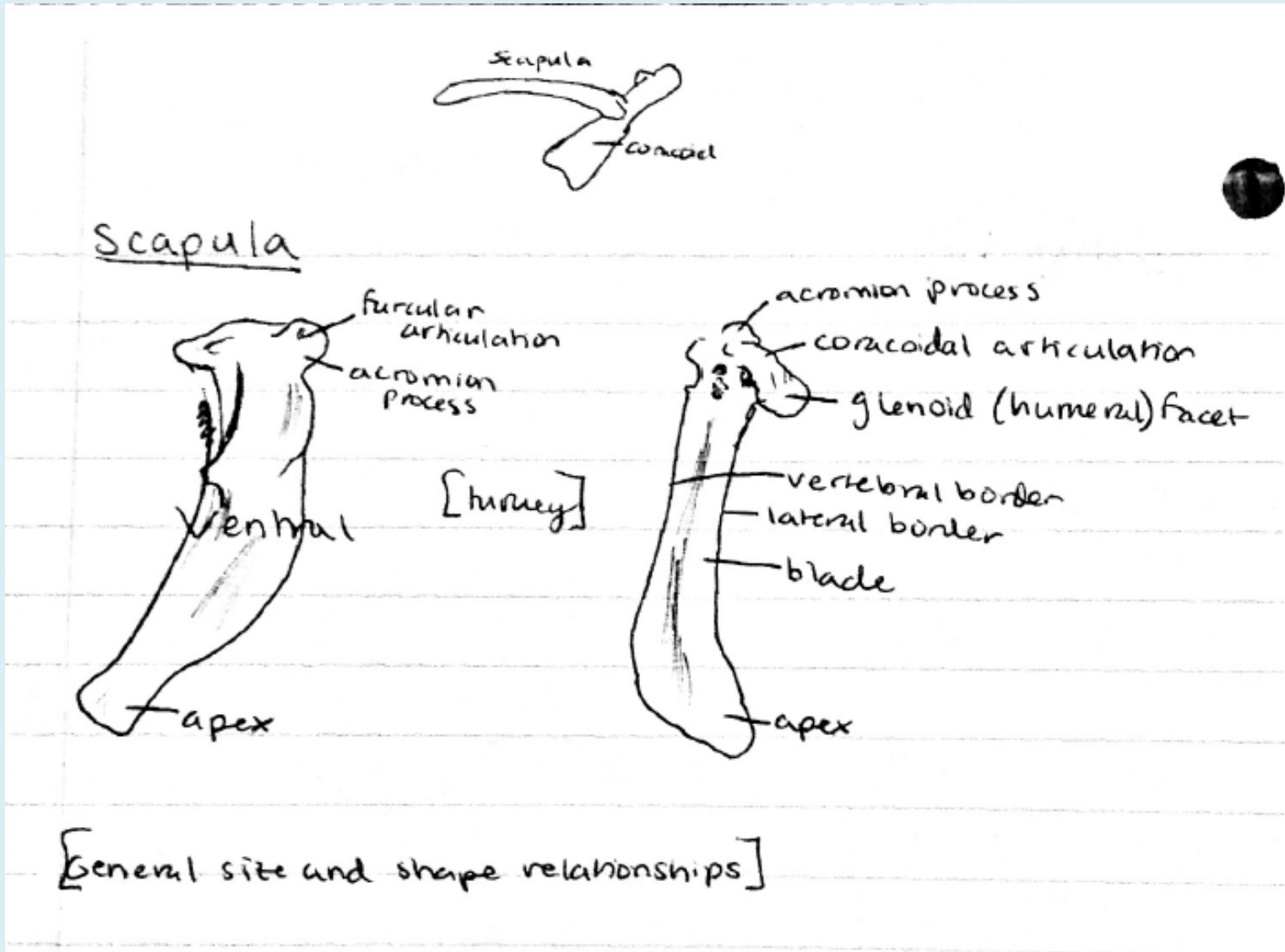


# Upper Limb

- Scapula
- Coracoid
- Furcula
  - Fused clavicles
  - Furculum =  $\frac{1}{2}$  furcula
- Humerus
- Radius
- Ulna
- Carpometacarpus
  - Fused carpals & metacarpals
- Phalanges
  - Digits 1-3, reduced



# General Scapula

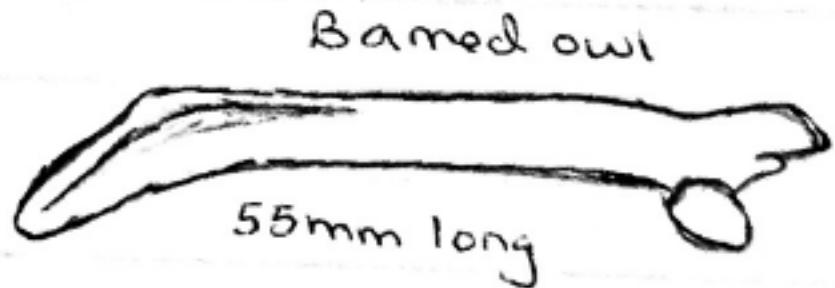
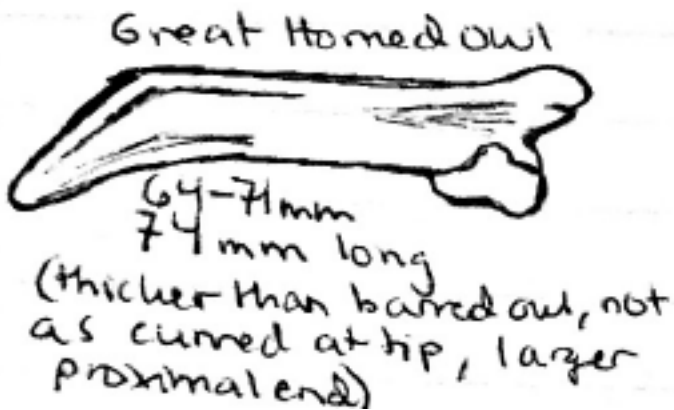
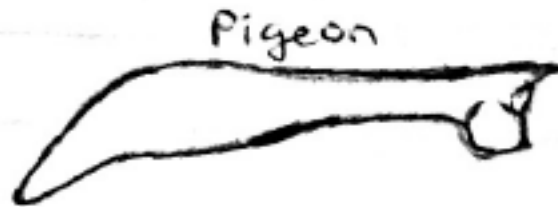
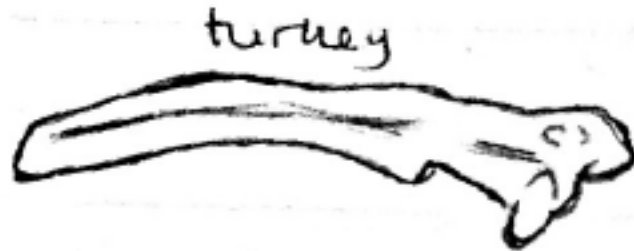
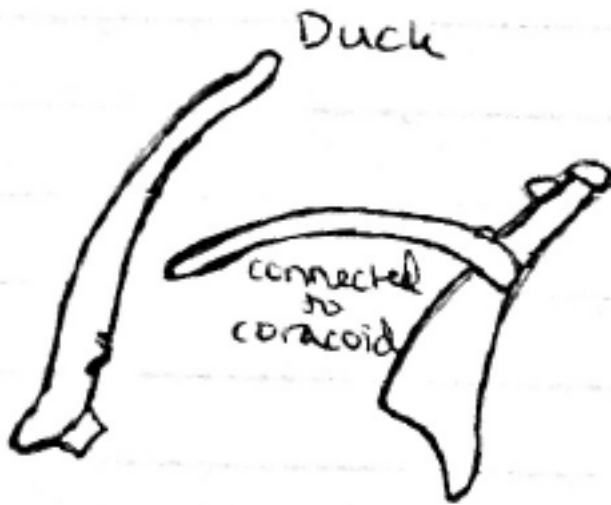




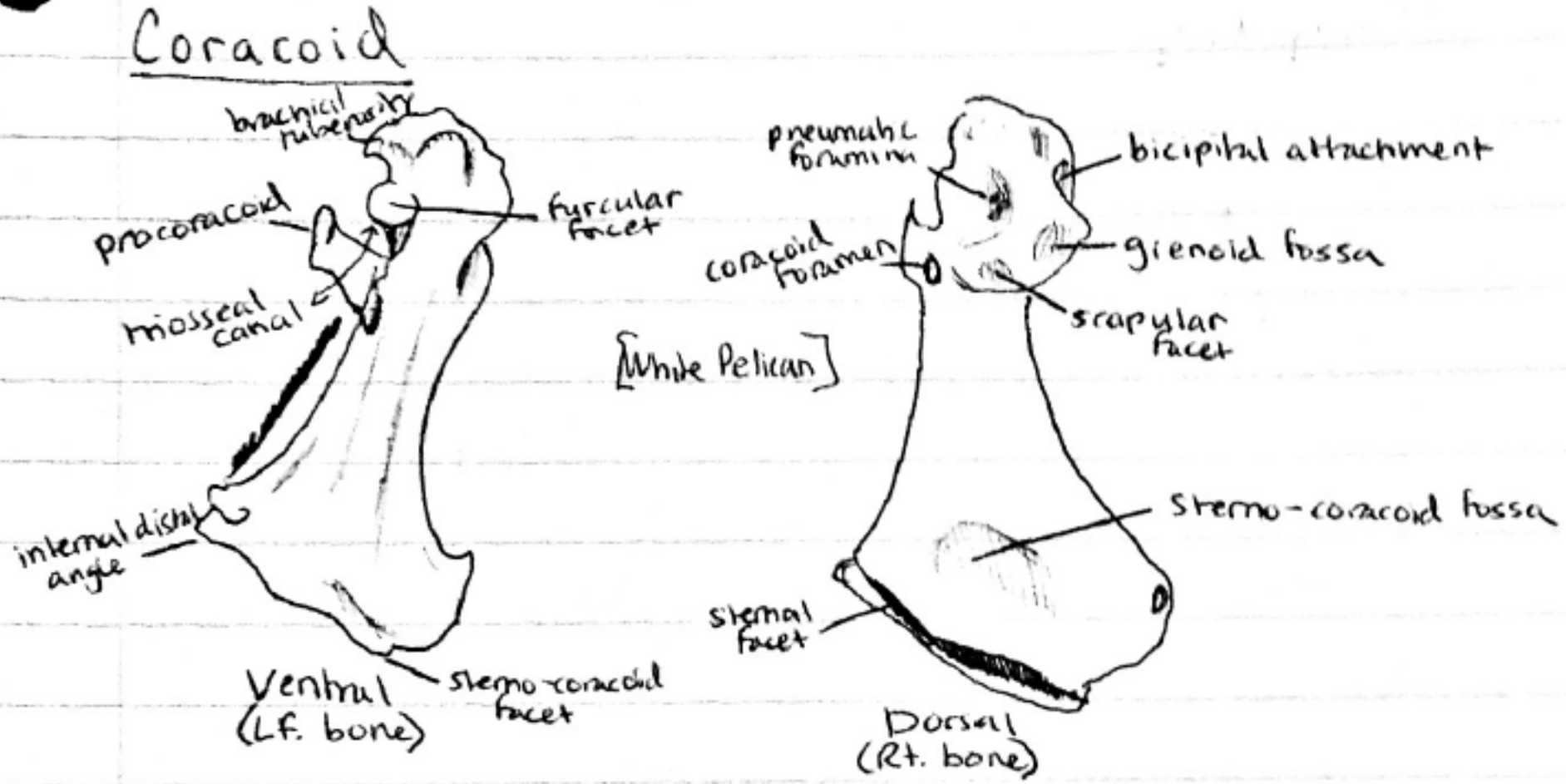


siding = hold the ventral side toward you and the top slants up to the side it's from (literally, not anatomical posterior)

## Scapulae



# General Coracoid



(or procoracoids)

# Coracoids



The foveolar facet is undercut by a deep, rounded, foramenated pit in doves and pigeons. The shaft is straight and slender. The brachial surface is undercut by a large pneumatic foramen.

bluejay

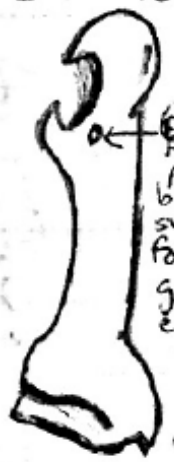
turkey



brachial tuberosity flat

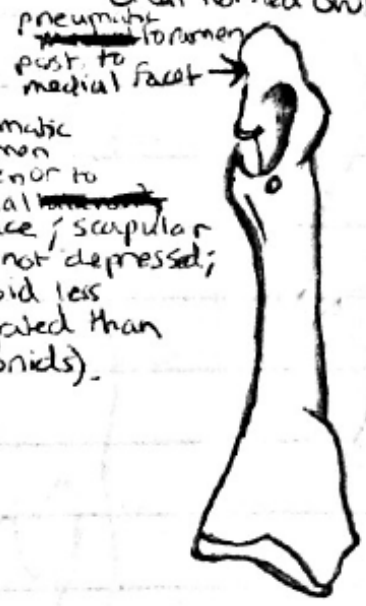
(large pneumatic foramen on dorsal surface above the sternal facet. The well developed ridge extending mesally from the procoracoid to the internal distal angle is often interrupted by a notch if not a complete coracoida fenestra in other groups such as the buteos).

Barred owl



pneumatic foramen posterior to brachial tuberosity; scapular facet not depressed; glenoid less elongated than tytonids).

Great Horned owl



crow



# Coracoid Notes

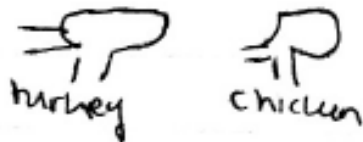
- **Turkey/Chicken:** Not square and flat. Kind of concave on both surfaces of distal end. Hole on back—external coracoid fossa. Facet is convex (not concave like goose/duck).
- **Goose/Duck:** Rectangular bottom (squared edge inferior—sternal facet at end—it's a long facet in duck and goose).
- **Owl/Hawk:** Coracoid foramen present. More square in chicken/turkey, but concave surfaces. Hawk is a little more irregular. Inferior edge has a small lip to it. Procoracoid in owls pointy/curvy—extension off anterior end. Hawk almost has procoracoid. Foramen in hawk is longer—owl more round.
- **Crow/Blue Jay:** Both have crest on back. No procoracoid or foramen. Look the same, different sizes.
- **Pigeon:** Irregular shape, flares out a lot at end (also has a procoracoid).

# Furculae ("wishbone") (clavicles)

Canada goose/duck = like rocking horse; really wide  
↳ curve in.

turkey/chicken — flat, not curved like goose or duck.

A handle where the two furculum come together.



owls/hawks — wide + skinny in owl — also longer.

more robust, rounded in hawk — horseshoe-

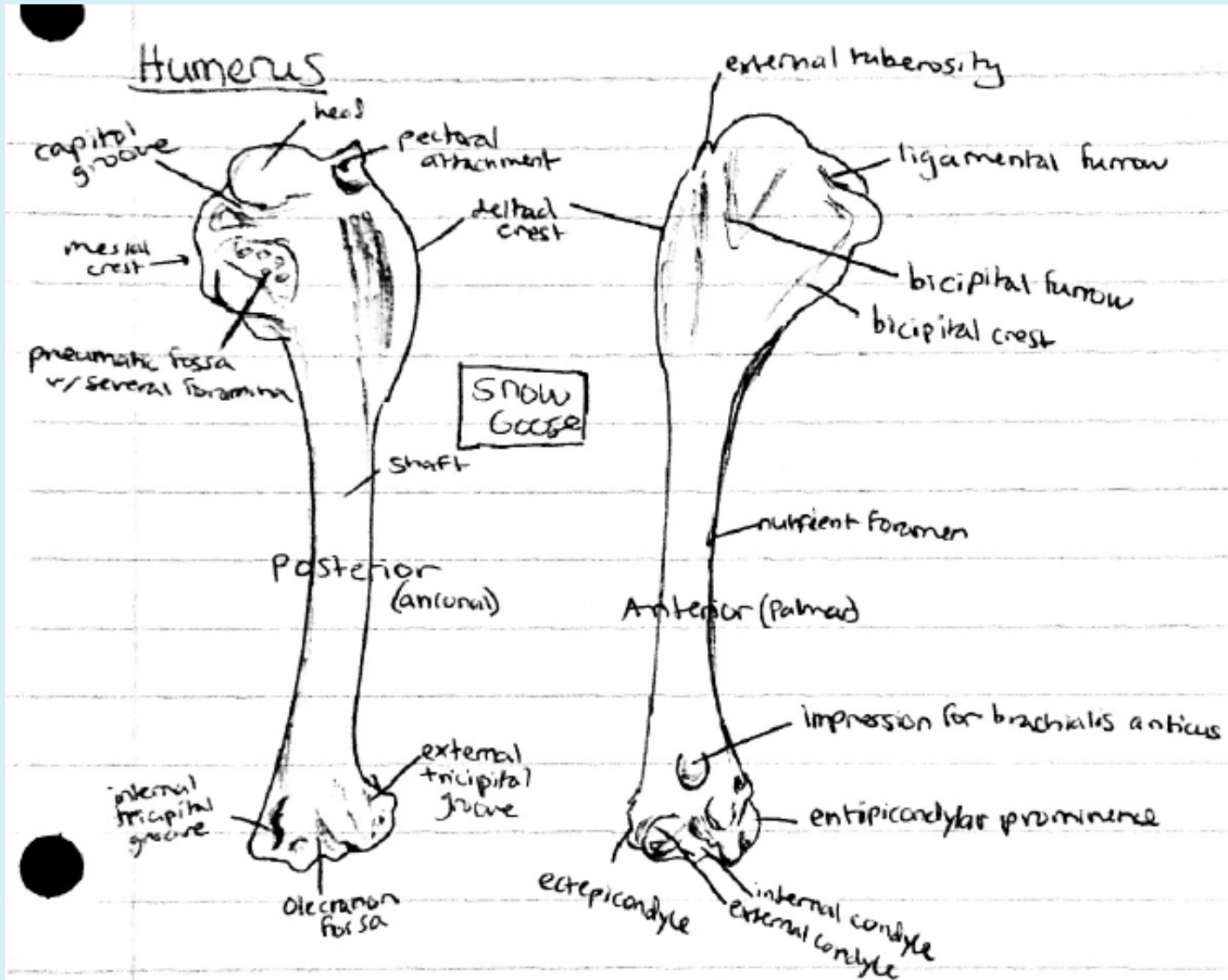
(but don't rock like goose/duck)

crow/BS — stirrups. know where Rt + Lt halves meet.

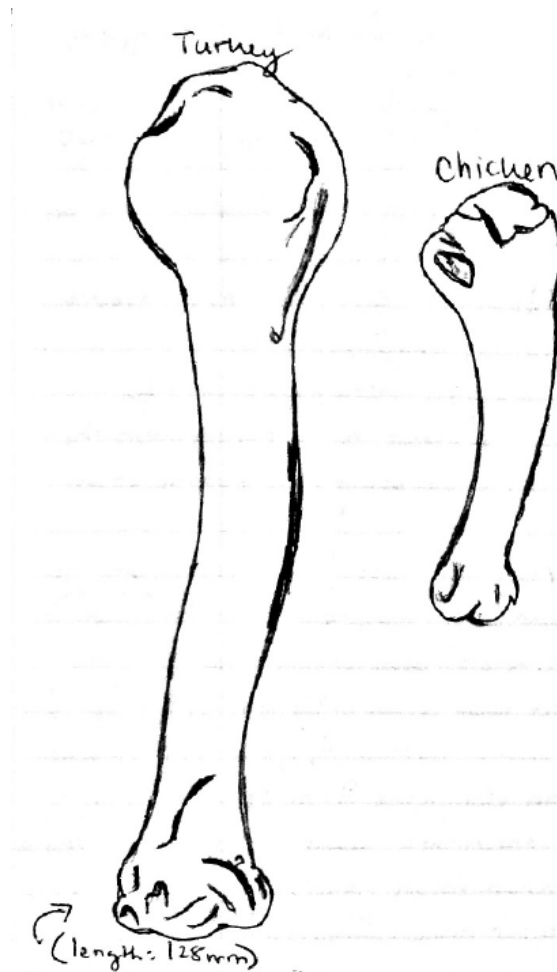
Ends are flared and skinny.

pigeon — no knob at connection. Flat and more stable than  
crow/BS (not flimsy stirrups). Ends not flared as much.  
Ends concave.

# General Humerus

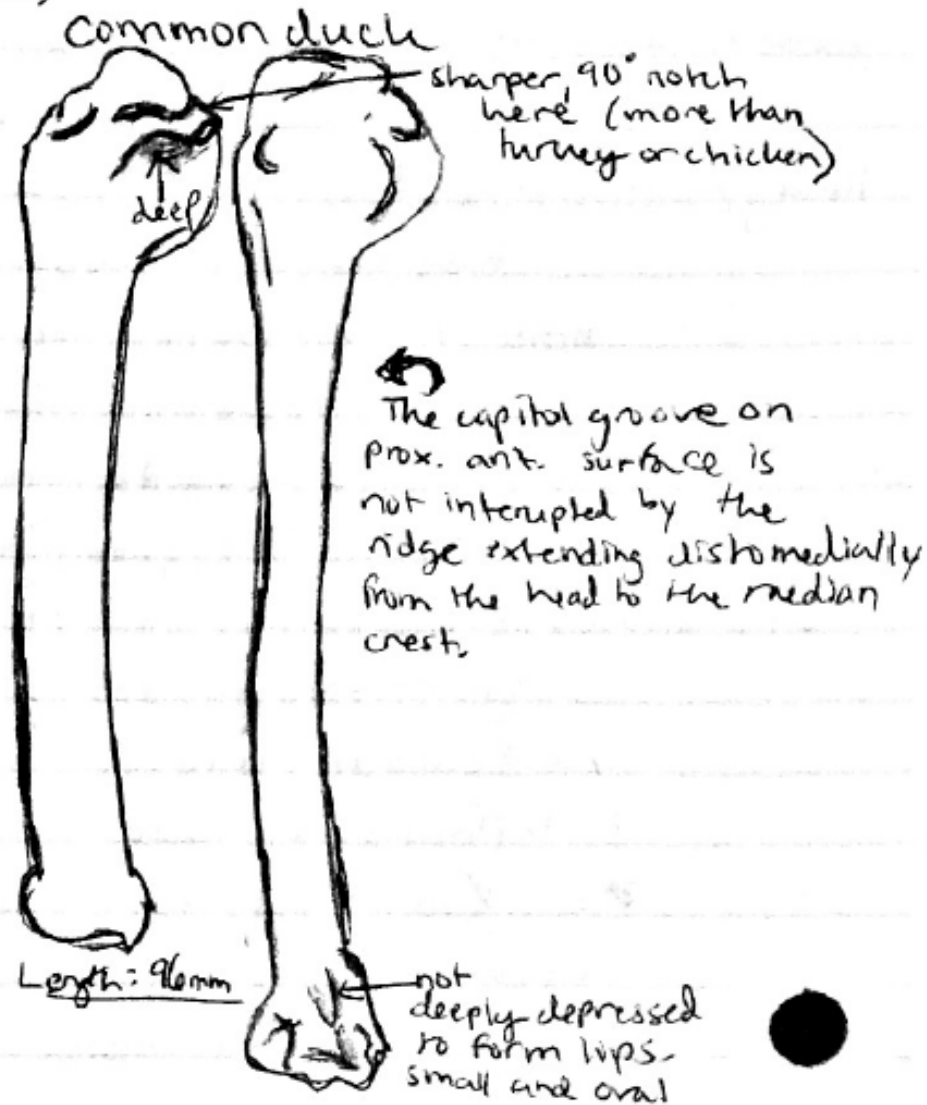


# Humeri: Turkey & Chicken



(length: 128mm)  
In galliformes, the capitulum groove is interrupted by a ridge extending distomedially from the head to the median crest. The depression for the brachialis anticus is oval and oriented at an angle to the shaft.

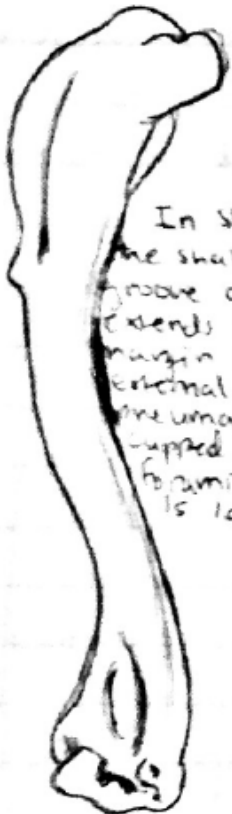
# Humerus: Duck





# Humeri: Owl and Hawk

Great Horned Owl

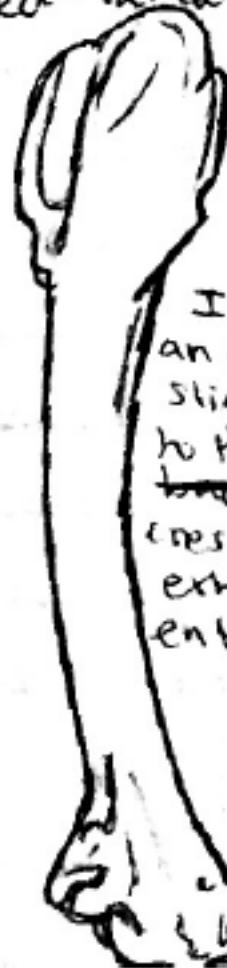


L: 128mm

In strigid owls, the shallow ligamentary groove containing 3 pits extends from the internal margin on the head to the external tuberosity. The pneumatic fossa is deeply cupped and contains several foramina. The ectepicondyle is large and knob like.

In strigiformes, the pneumatic foramen is hidden under the internal tuberosity and the head of the humerus is markedly oblong. There is a distinct pit between the shaft proper and the entepicondylar process.

Red-tailed Hawk



L: 120mm

In accipiters, there is an elongated depression slightly lateral and distal to the pneumatic fossa at the ~~base of~~ base of the median crest. The ulcranon fossa extends prox. to separate the entepicondylar process.

entepicondylar prominence distal to the internal condyle

# Humeri: Crow & Pigeon

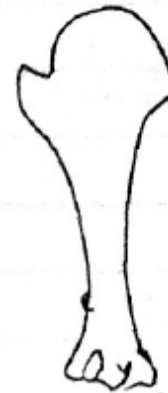
Common Crow

L: Damm



In passeriformes, the entepicondylar process (\*) is directed proximally, toward the head of the humerus. The depression for attachment of brachialis anticus (\*\*\*) just above the distal epicondyles, is shallow and rises to the median edge of the anterior surface. There is a distinct round tuberosity proximal to the entepicondyle.

Pigeon

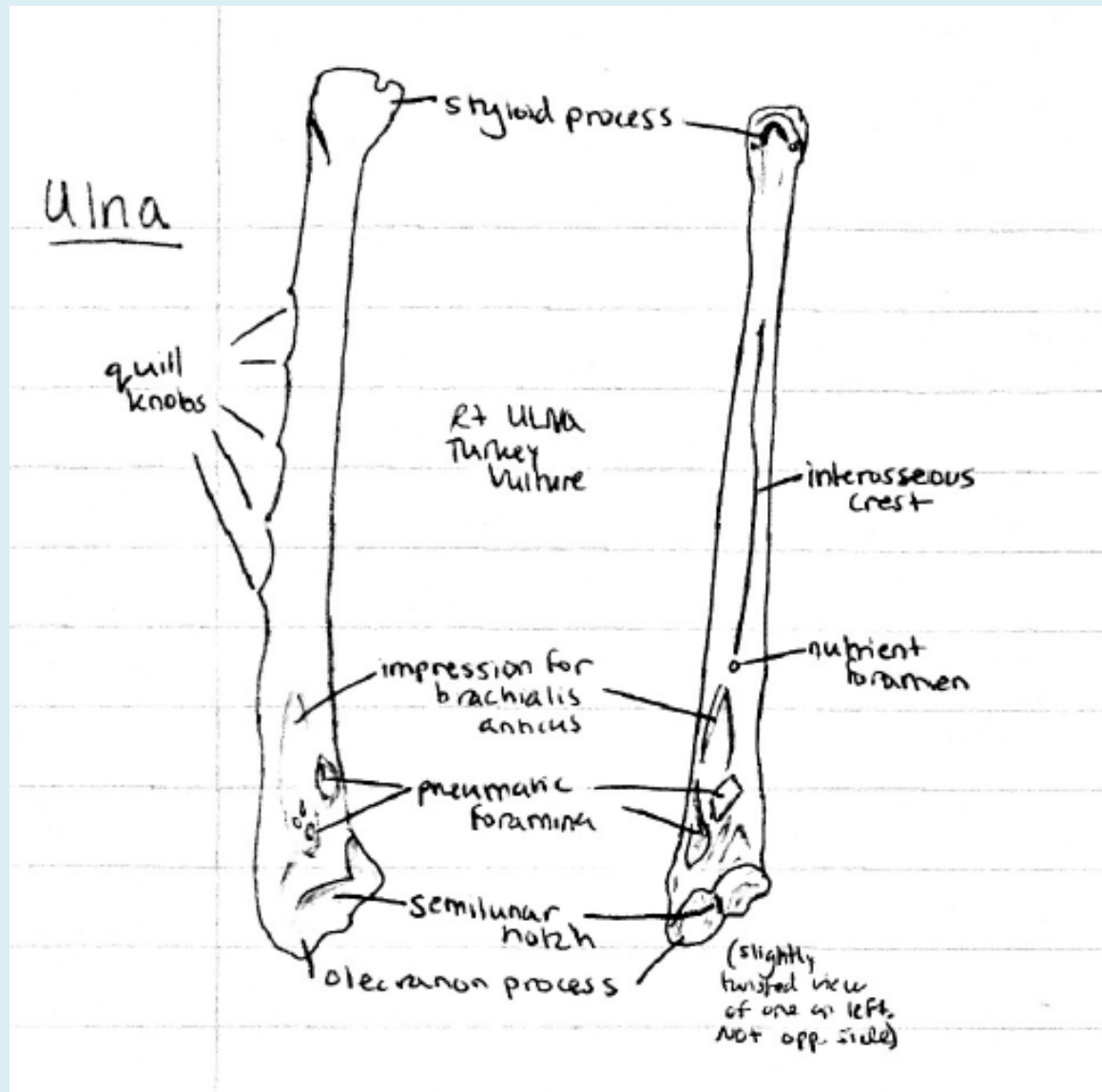


pneumatic foramen like a hole in a hole, (not cancellous sponge, more filled in)

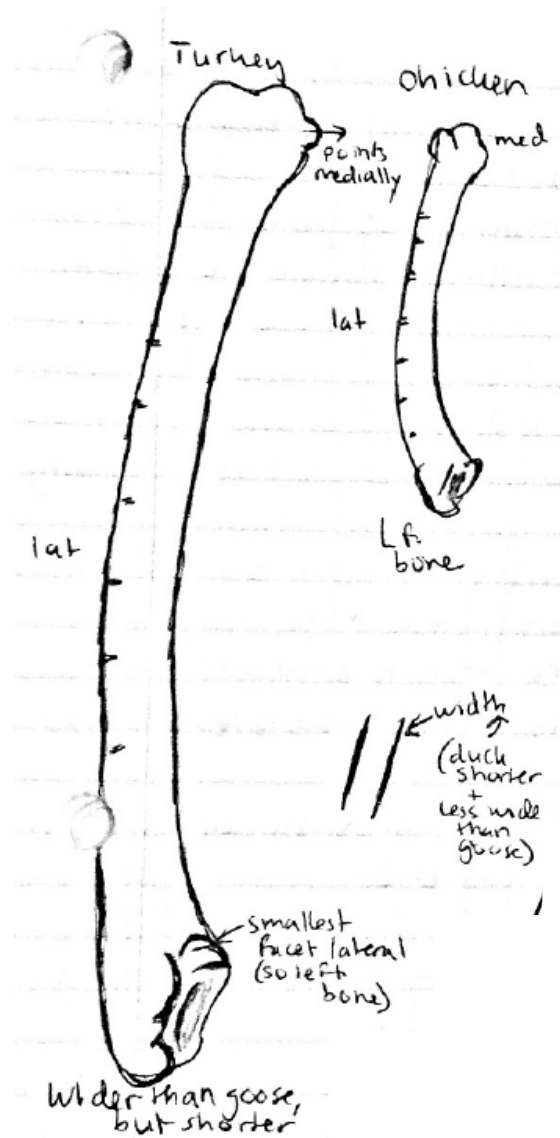
# Humerus Notes

- **Turkey/Chicken:** Shorter and stubbier than goose/duck. Pneumatic fossa doesn't have the same cancellous bone look as goose/duck. In Galiformes, the capitol groove is interrupted by a ridge extending dorsomedially from head to median crest. Depression for brachialis articus is ovoid and oriented at an angle to the shaft.
- **Goose/Duck:** Long and slender. Pneumatic fossa (cancellous bone look). Anterior and lateral crest on proximal end.
- **Owl/Hawk:** Pretty curved (not straight like goose). Deltoid crest has raised line than goes halfway up on hawk. Forms oblique angle with groove; where owl is more 90 degrees. Pneumatic fossa doesn't have many foramina.
- **Crow/Blue Jay:** Medial epicondyle is fairly prominent. Also a line on crow like owl—proximal anterior surface by deltoid crest (oblique angle as well). Medial epicondyle extends distally. BJ also has line like owl.
- **Pigeon:** Fairly flared proximal portion. Pneumatic foramen more like a fossa (big indent). Tiny "nipple" on infralateral shaft.

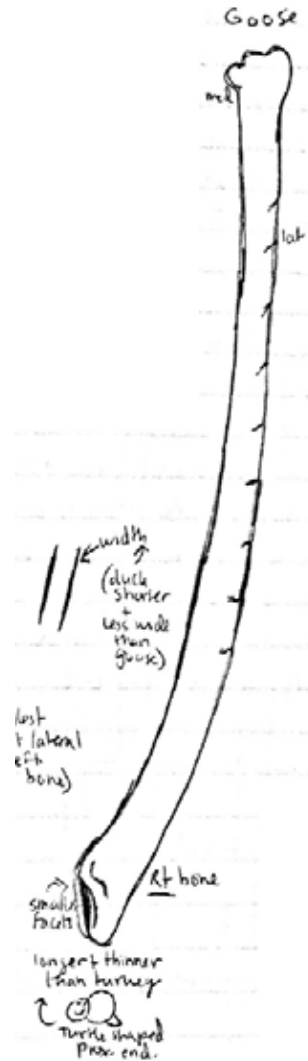
# General Ulna



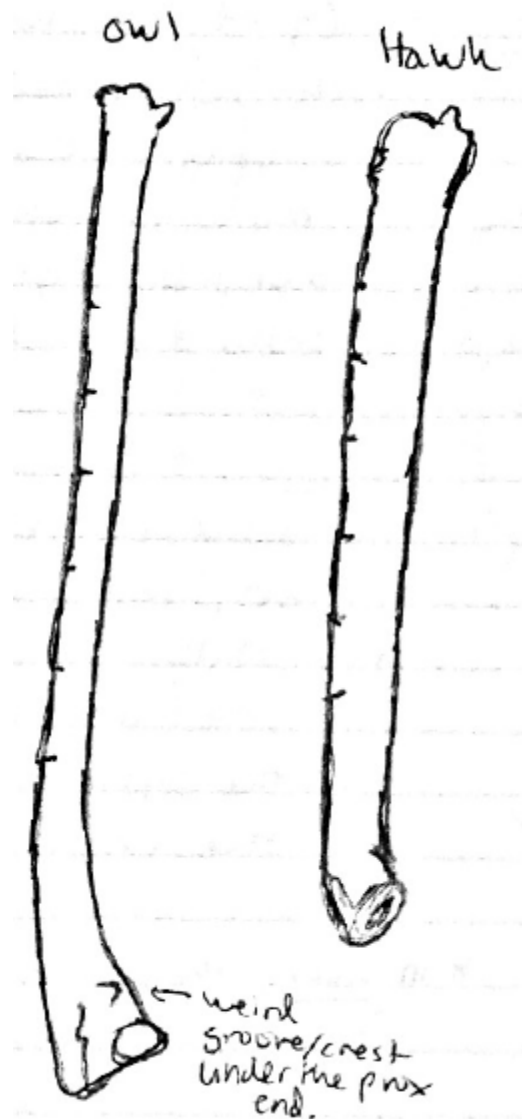
# Ulnae: Turkey & Chicken



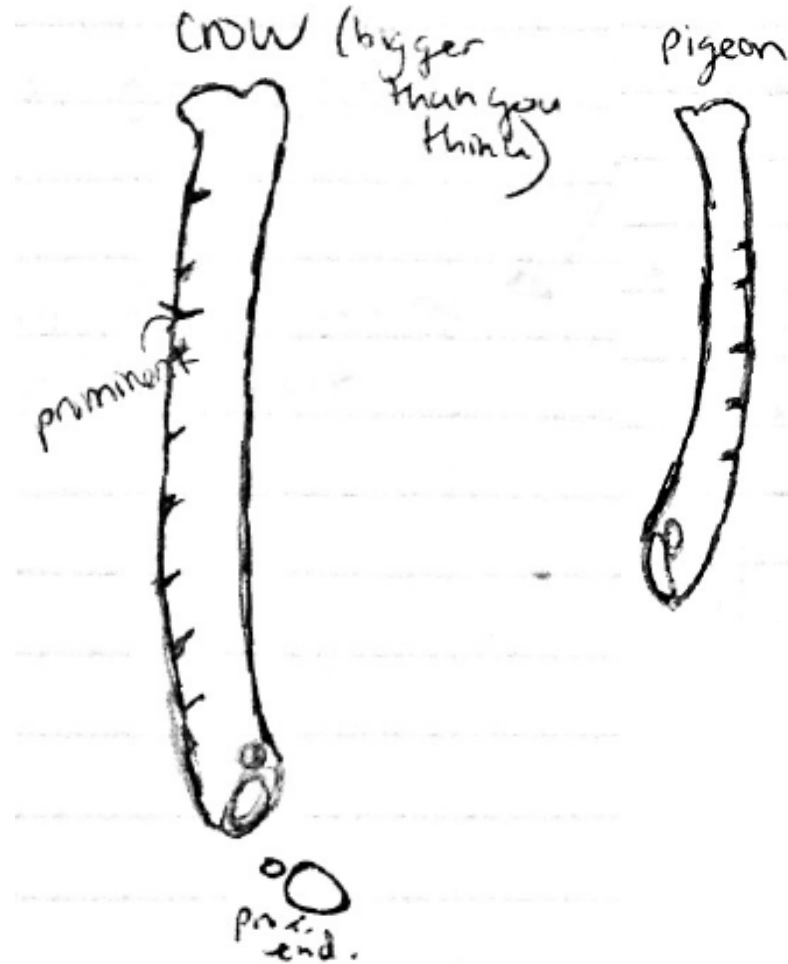
# Ulna: Goose



# Ulnae: Owl & Hawk



# Ulnae: Crow & Pigeon



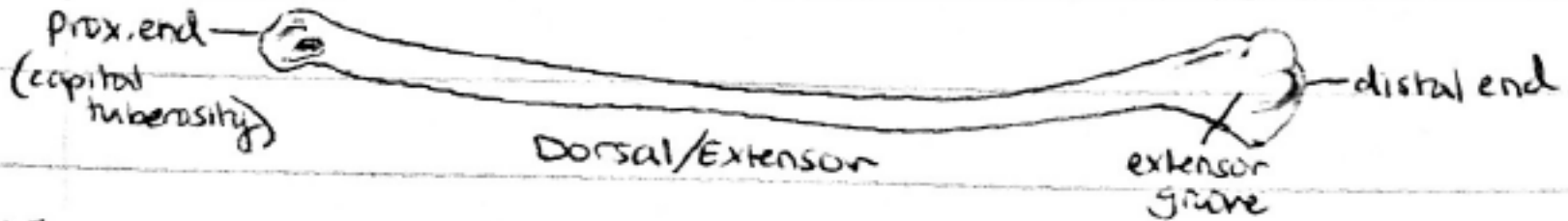


# Ulna Notes

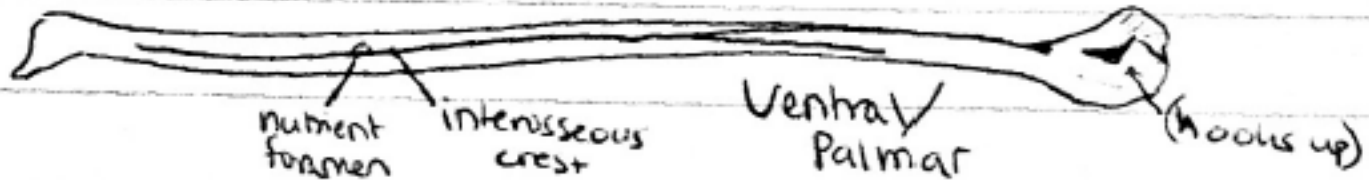
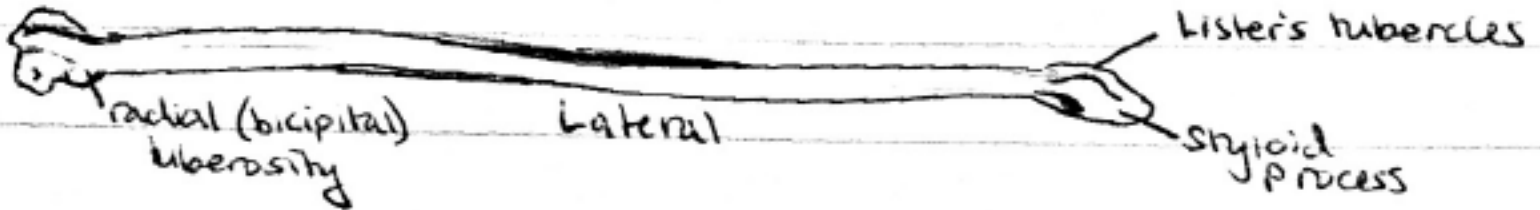
- **Turkey/Chicken:** More robust and short (goose is longer and slightly thinner than turkey).
- **Goose/Duck:** Styloid process distal end looks like "finger," concave facet (they all do). "Fist giving thumbs up."
- **Owl/Hawk:** Hawk more robust than the longer, thinner owl.
- **Crow/Blue Jay:** Crow larger version of BJ.
- **Pigeon:** No specific notes.

# General Radius

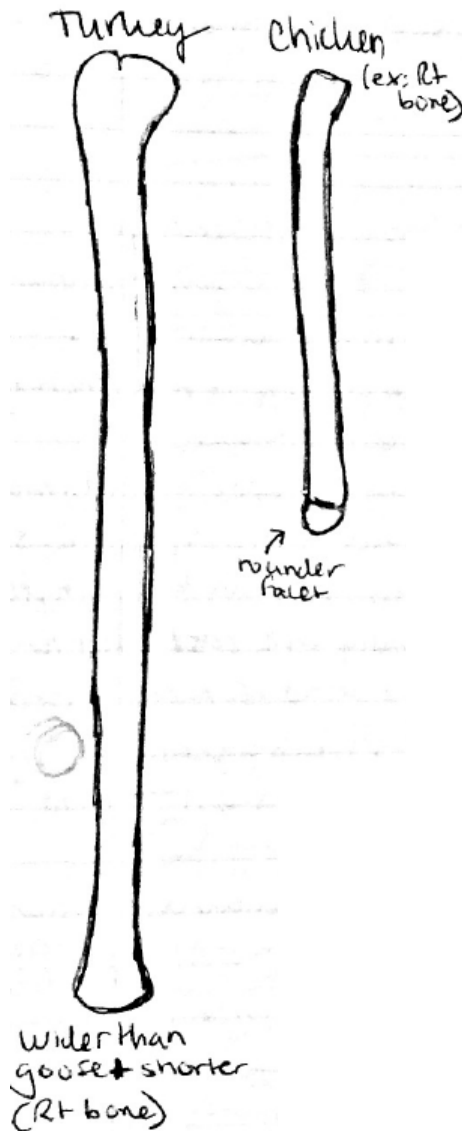
## Radius



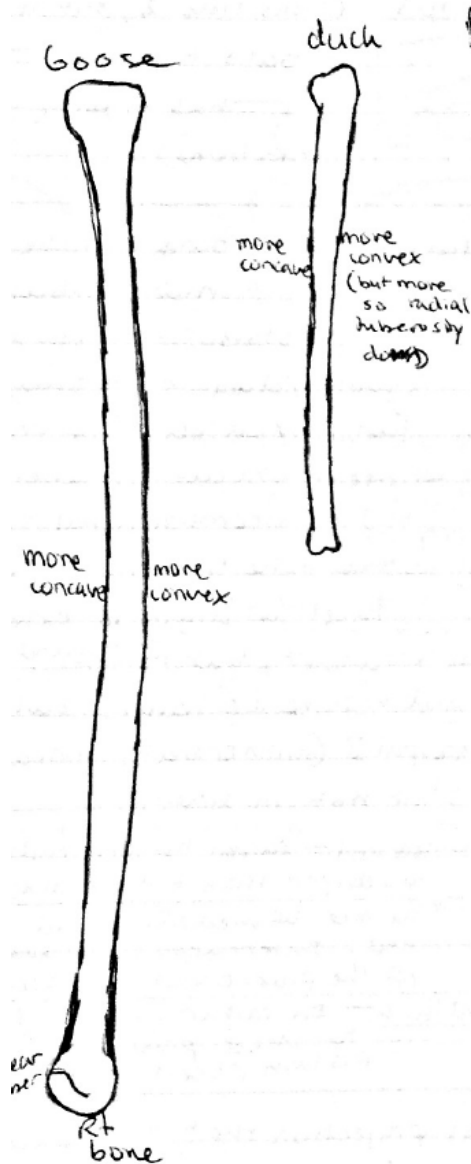
Turkey  
culture



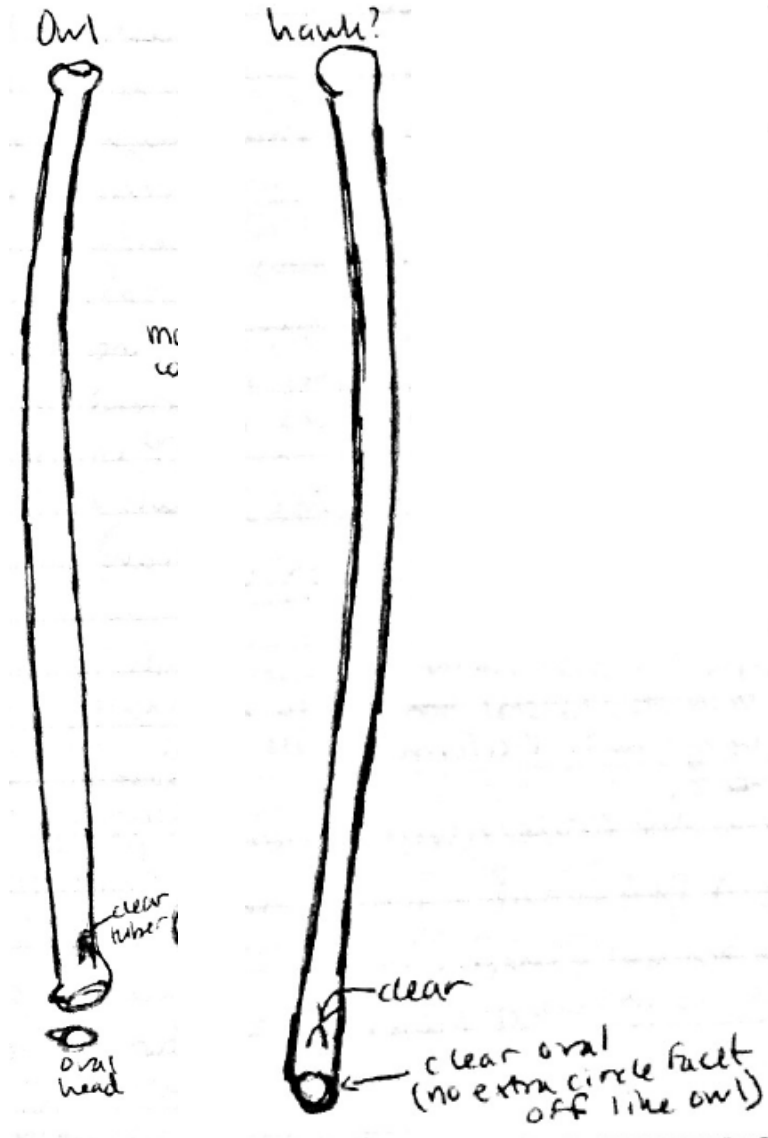
# Radii: Turkey & Chicken



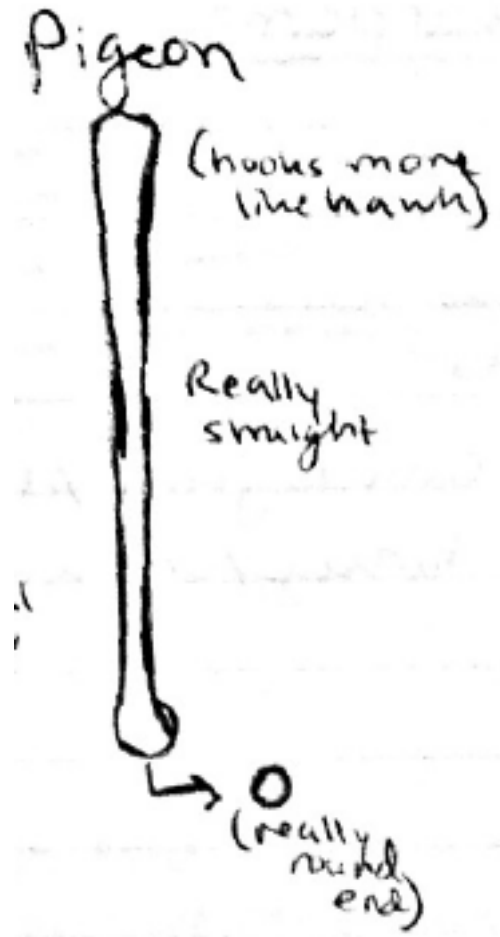
# Radii: Duck & Goose



# Radii: Owl & Hawk



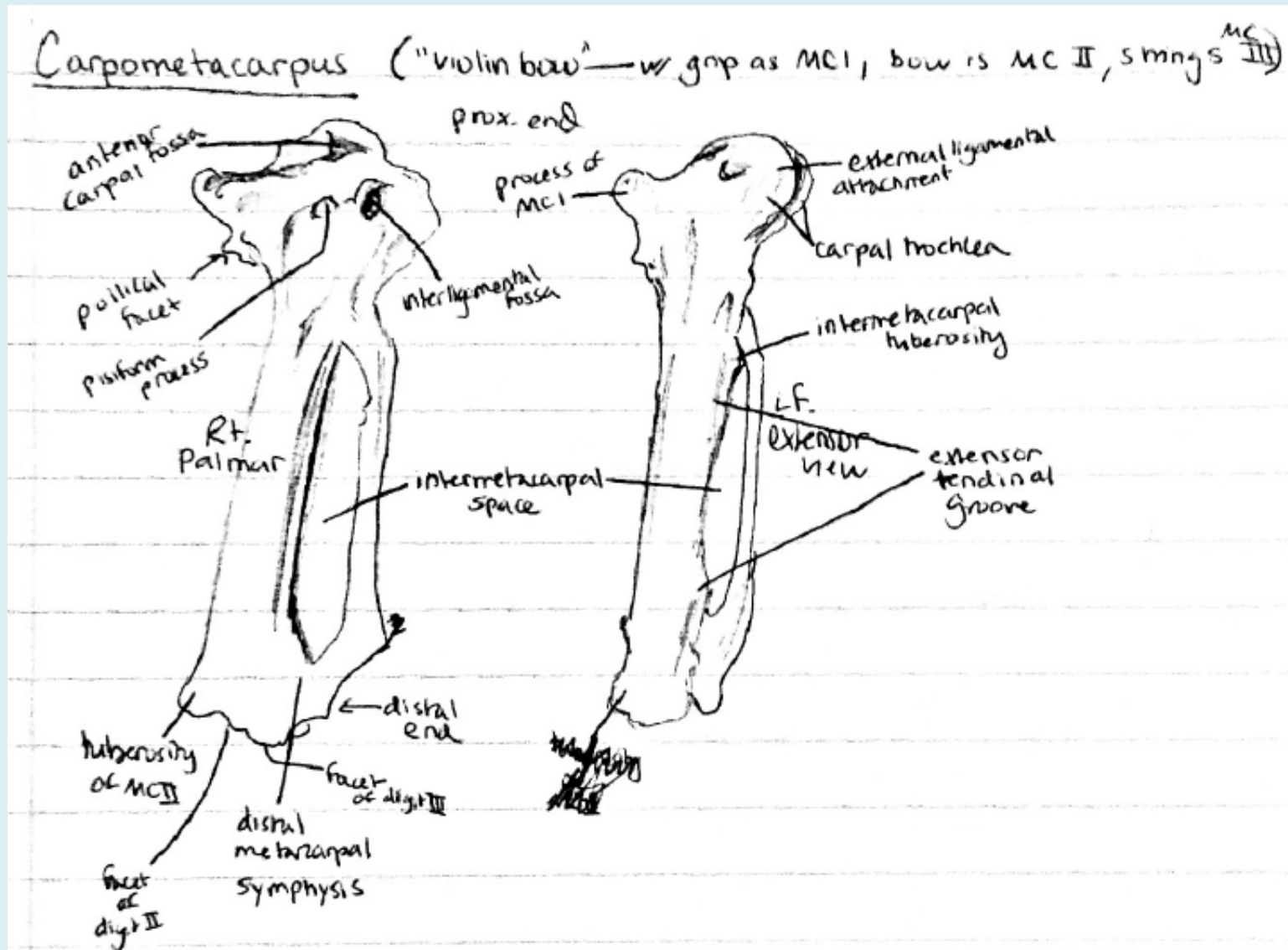
# Radius: Pigeon



# Radius Notes

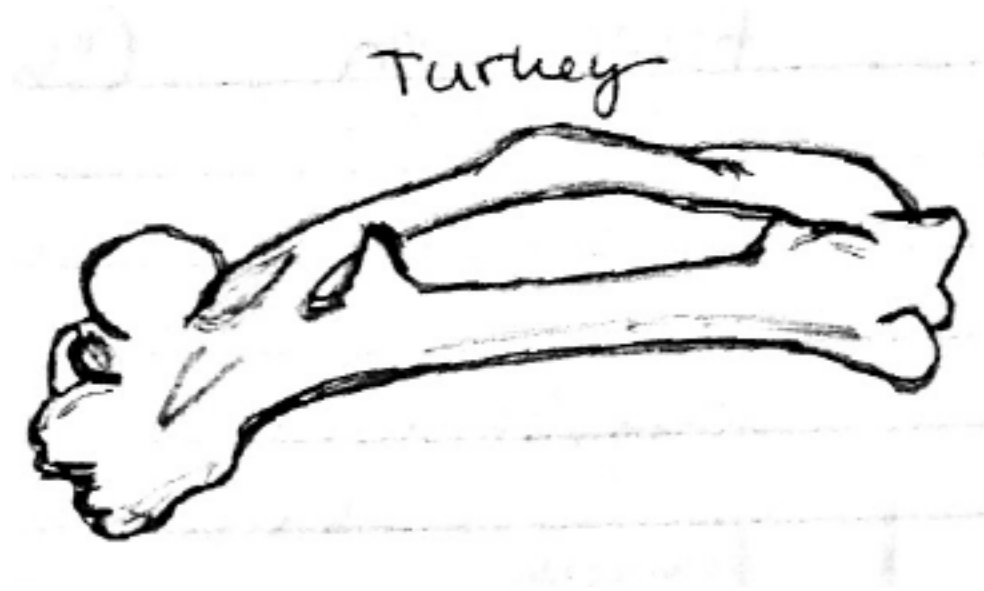
- (Good luck if you have to distinguish these—size comparison game).
- **Turkey/Chicken:** More robust and shorter than goose/duck.
- **Goose/Duck:** Distal end doesn't flap over like hawk (rounded end). Long and slender (ends flare slightly).
- **Owl/Hawk:** Owl has longer and thinner radius. Hawk more robust. Interosseous crest in owls is continuous with a fragile, bony bridge at proximal end. Owl also hooks distally so it's sharp—more than hawk.
- **Crow/Blue Jay:** Crow larger version of BJ
- **Pigeon:** No specific notes.

# General Carpometacarpus

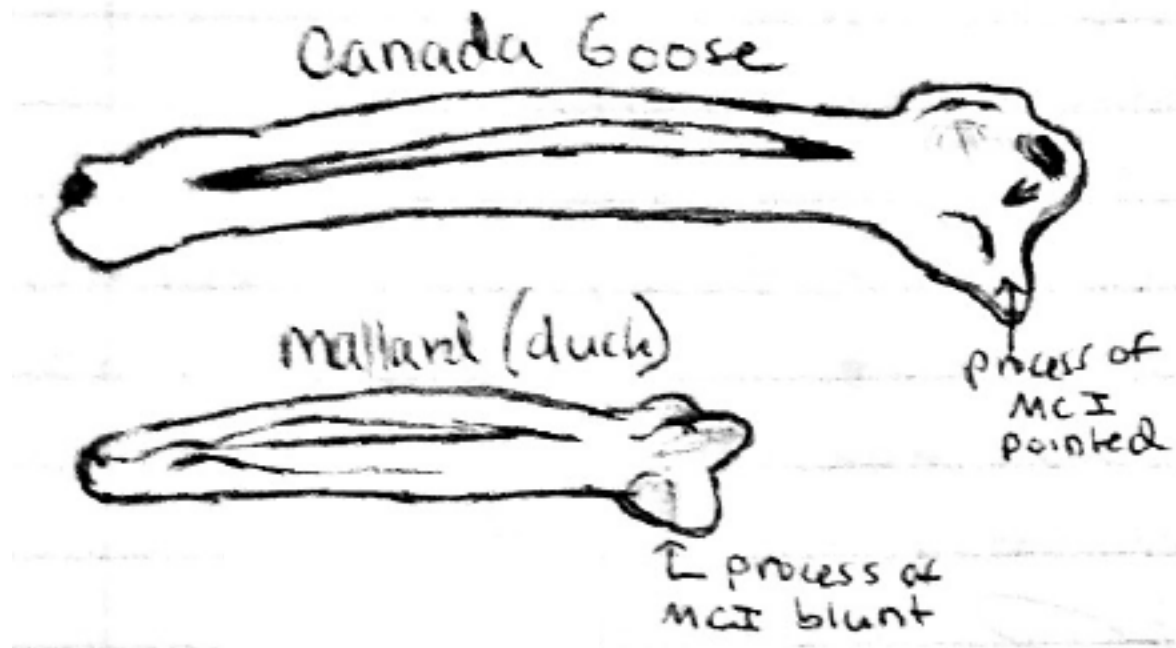




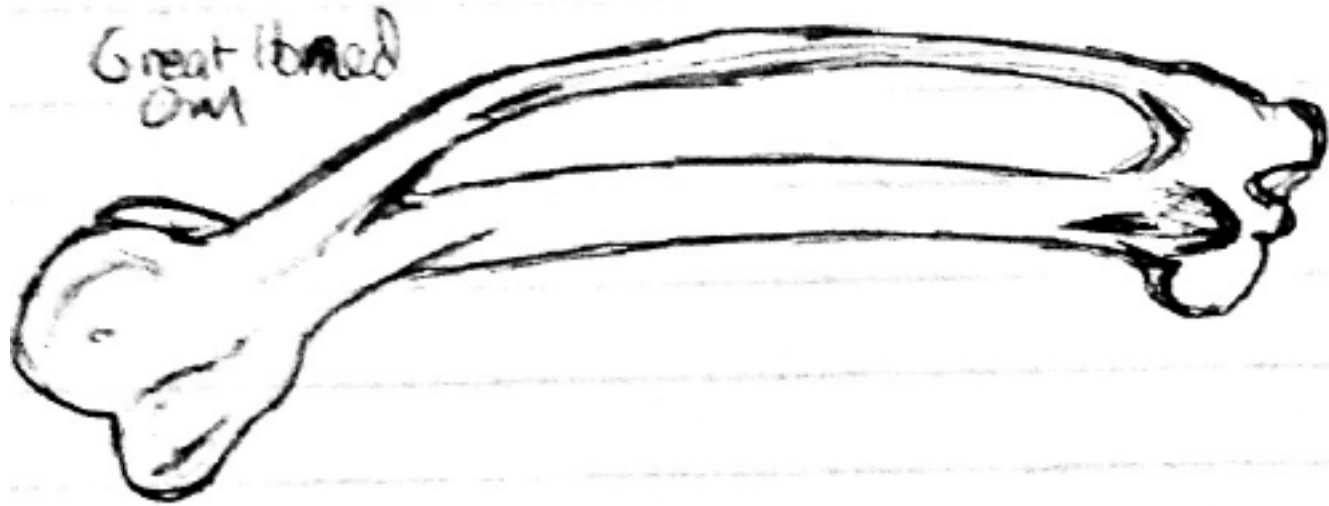
# Carpometacarpi: Turkey & Chicken



# Carpometacarpi: Duck & Goose



# Carpometacarpi: Owl & Hawk

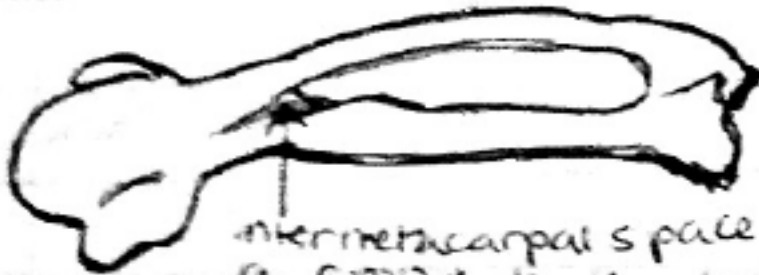


# Carpometacarpi: Crow & Pigeon

Common Crow



Domestic Pigeon



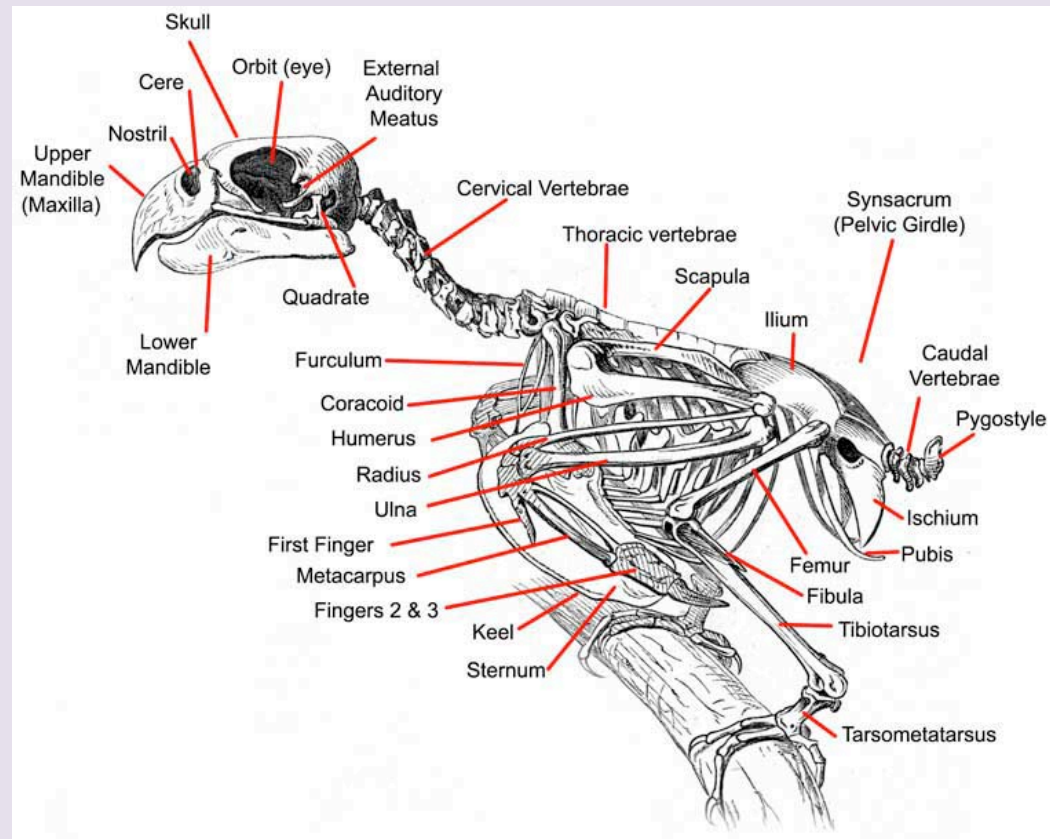
intermetacarpal space continuing prox- as a groove to the level of the carpal trochlea

# Carpometacarpus Notes

- **Turkey/Chicken:** Short, robust, and really small compared to tibiotarsus—so don't think smaller bird. Turkey/chicken more bowed. Turkey intermetacarpal tuberosity well developed, may bridge intermetacarpal space in older birds. Space ca. 50% total bone length.
- **Goose/Duck:** Short bone. Note process of MC1. Straighter, streamlined.
- **Owl/Hawk:** Long and slender, but not round in owls. Kind of compressed and ~ same as hawk. Owls tend to be bigger. MC2 shaft (the skinnier shaft) is concave on outside in owl—giant "D," but not in hawk.
- **Crow/Blue Jay:** Has projection that bridges MC2 and MC3 on both. Also triangle cross-section for both. Again, pretty much the same, except crow larger.
- **Pigeon:** Long projection superiorly. No projection between MC2 and MC3. Intermetacarpal tuberosity is pronounced. Large pisiform process. Intermetacarpal space continuing proximally as a groove to the level of the carpal bones.

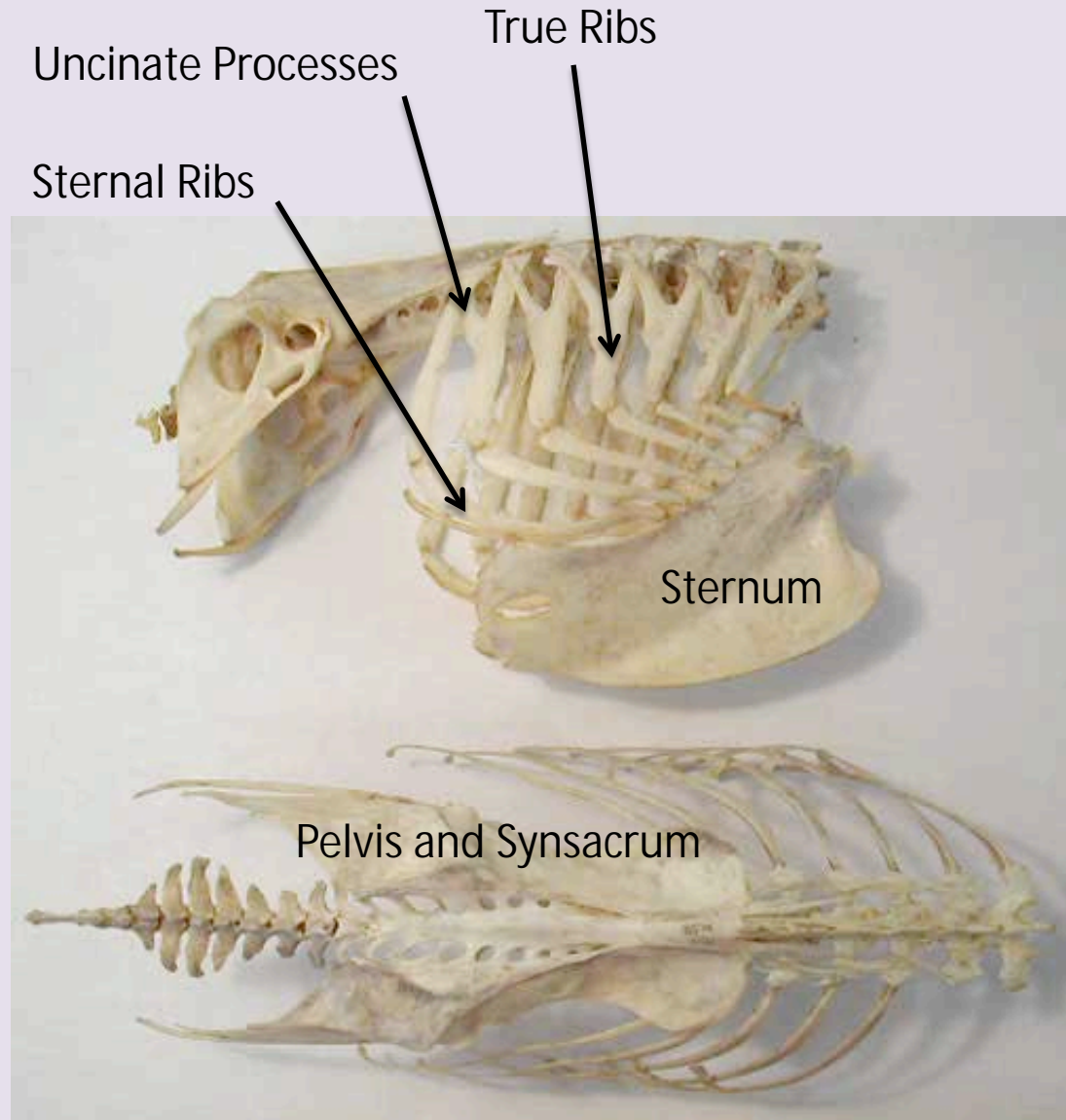
# Vertebral Column

- Cervical vertebrae
- Notarium
  - Upper thoracic
- Synsacrum
  - Lower thoracic, lumbar, and sacral
- Caudal vertebrae
- Pygostyle
  - Last caudal

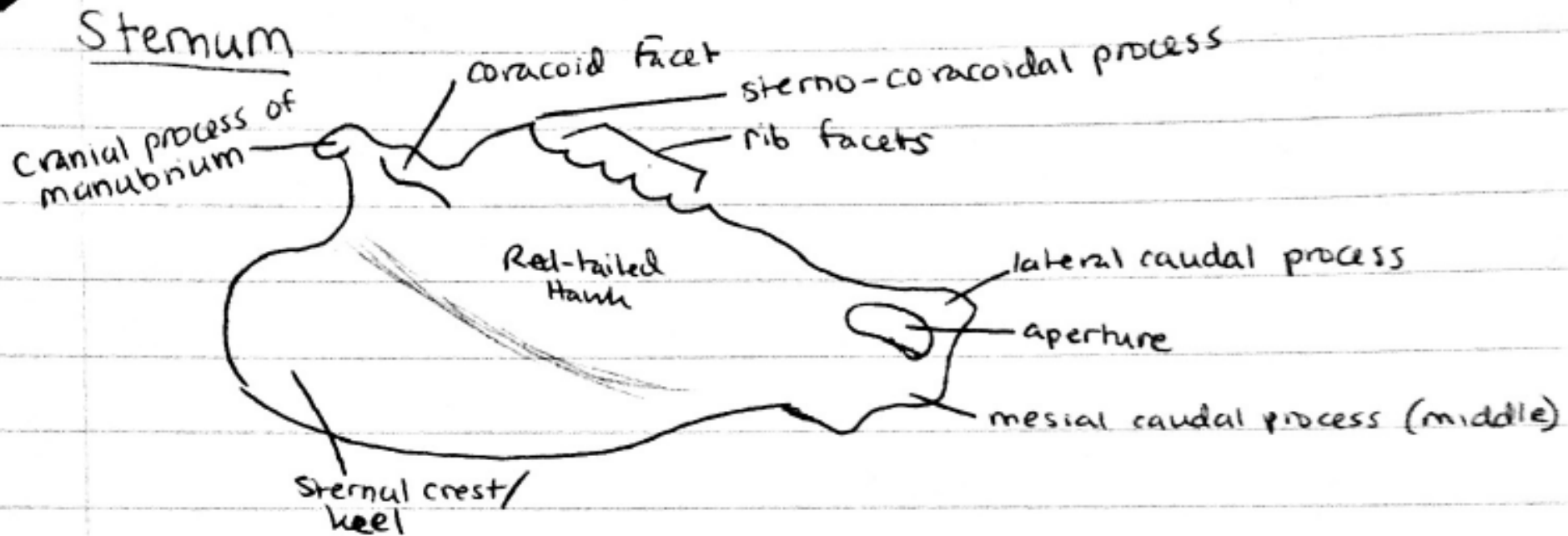


# Thorax

- True ribs
  - With uncinata processes
- Sternal ribs
- Sternum
  - Carina = keel
  - Carinates (birds with keel)
  - Ratites (flightless birds, no keel)



# General Sternum

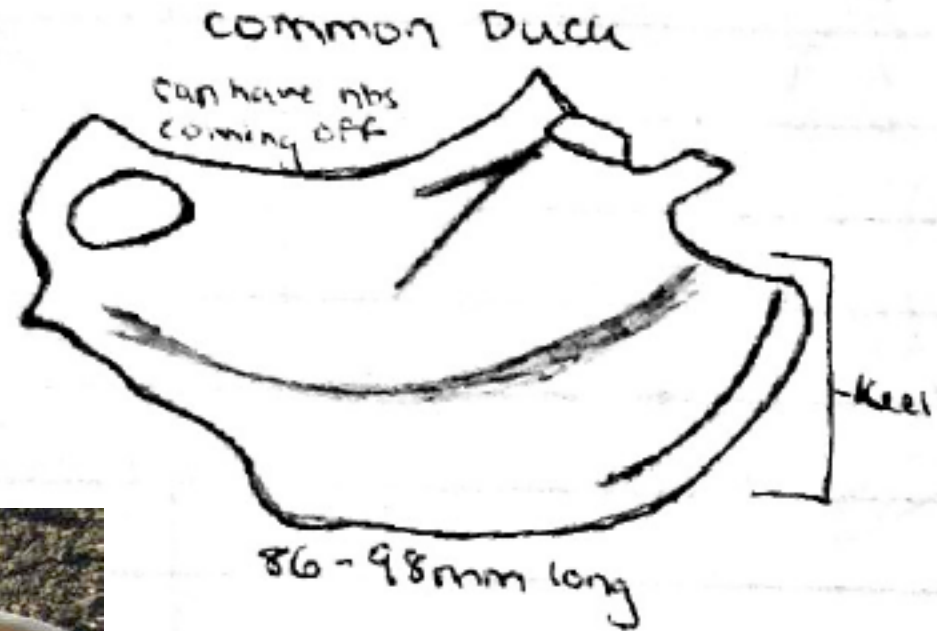




# Sterna: Turkey & Chicken



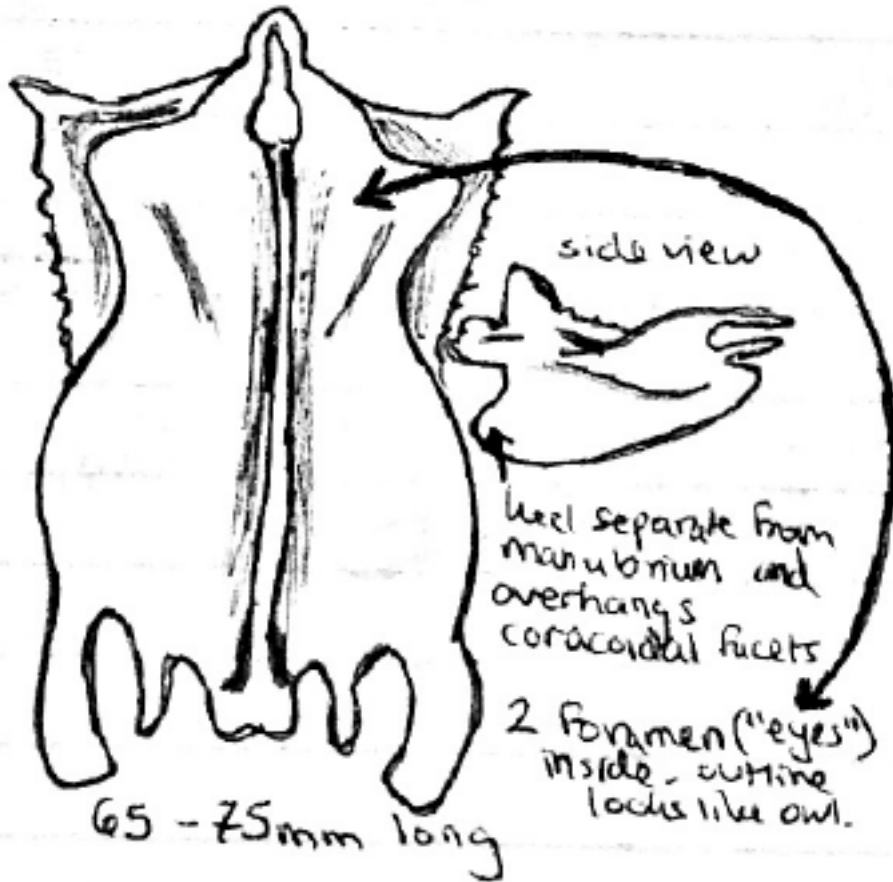
# Sterna: Duck & Goose



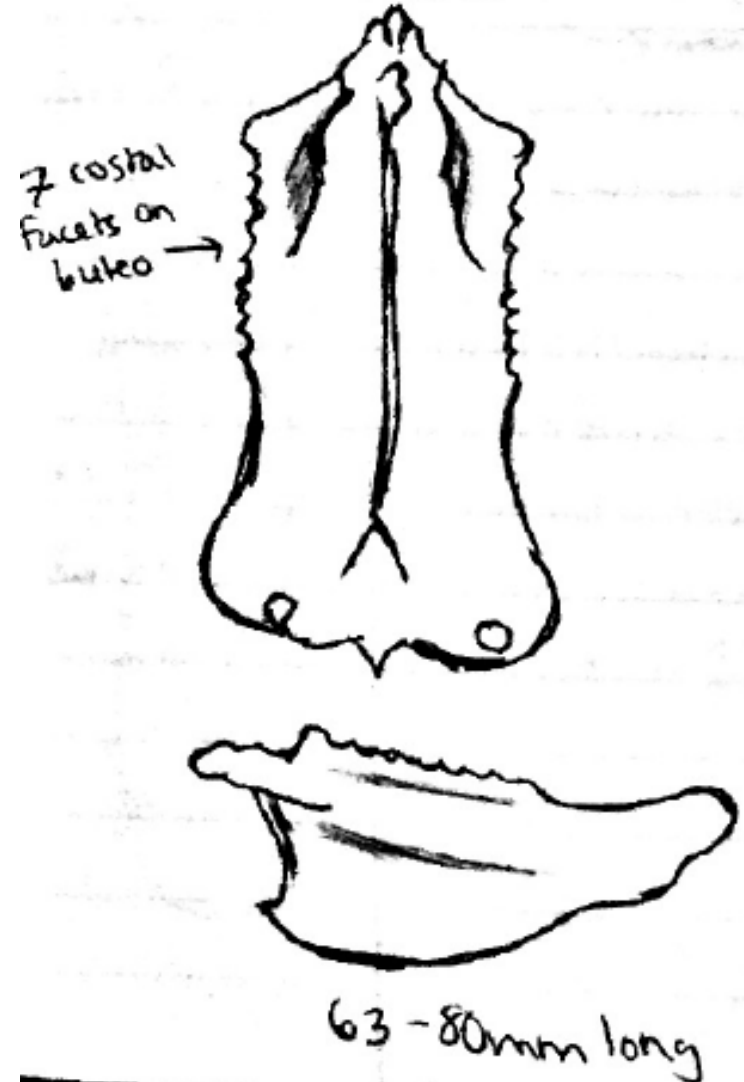
Goose

# Sterna: Owl & Hawk

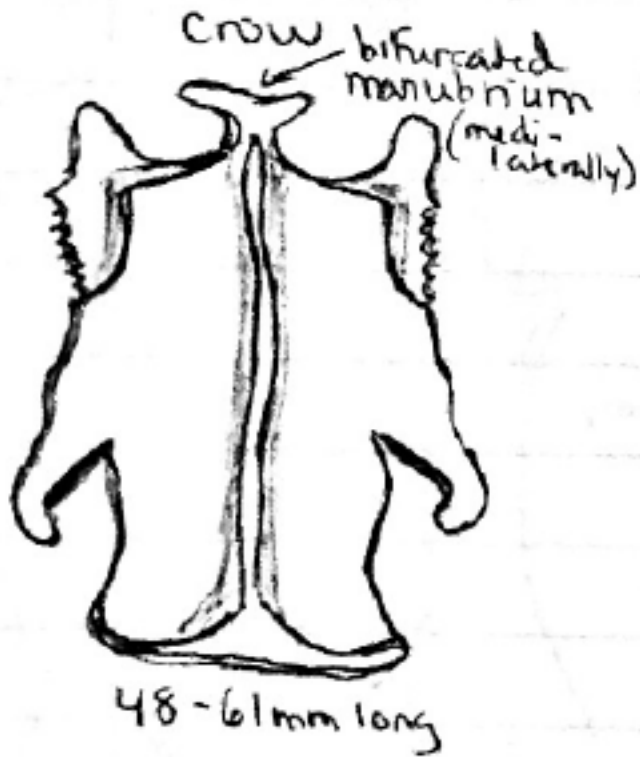
Great Horned Owl



Hawk



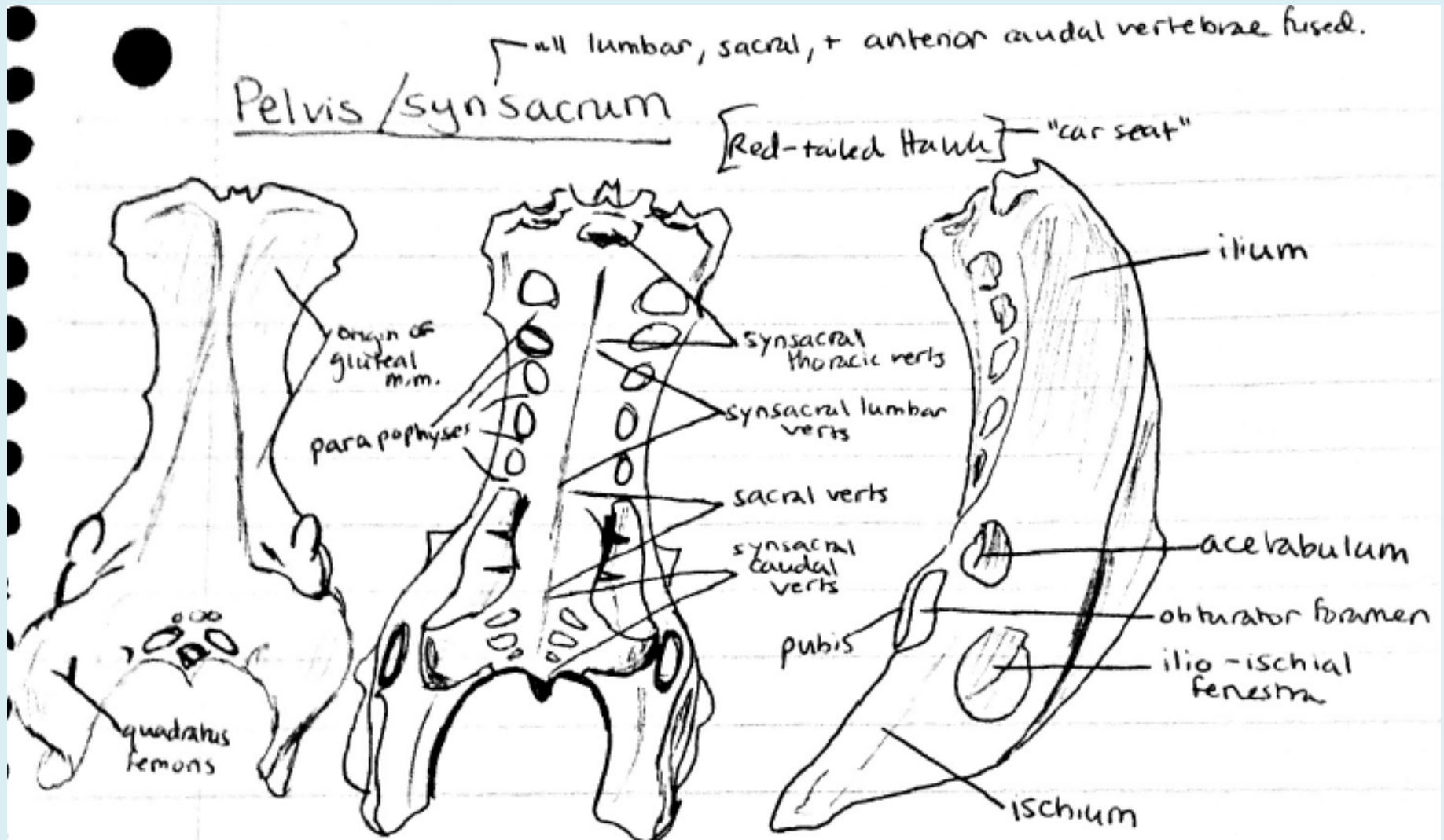
# Sterna: Crow & Pigeon



# Sternum Notes

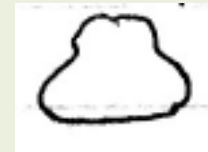
- **Turkey/Chicken:** “mutant” (looks like manta ray with a large keel). Chicken looks more like an insect. (Pointed, arched keel and keel ends before end of sternum body).
- **Goose/Duck:** 2 long arms projecting inferiorly. Keel travels down all of the sternum body.
- **Owl/Hawk:** Owl variable in size—not always bigger than hawk. It looks like an owl in outline from interior view (owl tufts, head, eyes, and body). Hawk has 2 foramina down on the distal end and it doesn't have as many projections.
- **Crow/Blue Jay:** BJ—looks kind of like duck/goose, but tiny—and bifurcated process at the end. Keel looks like shark fin. Crow—looks a lot like BJ, but larger. Also bifurcated. Distance of bifurcated tip important in distinguishing BJ from other smaller birds.
- **Pigeon:** Narrow and tall with 2 large foramina on either side of keel. Pigeon has small bifurcation at end.

# General Pelvis and (Fused) Synsacrum



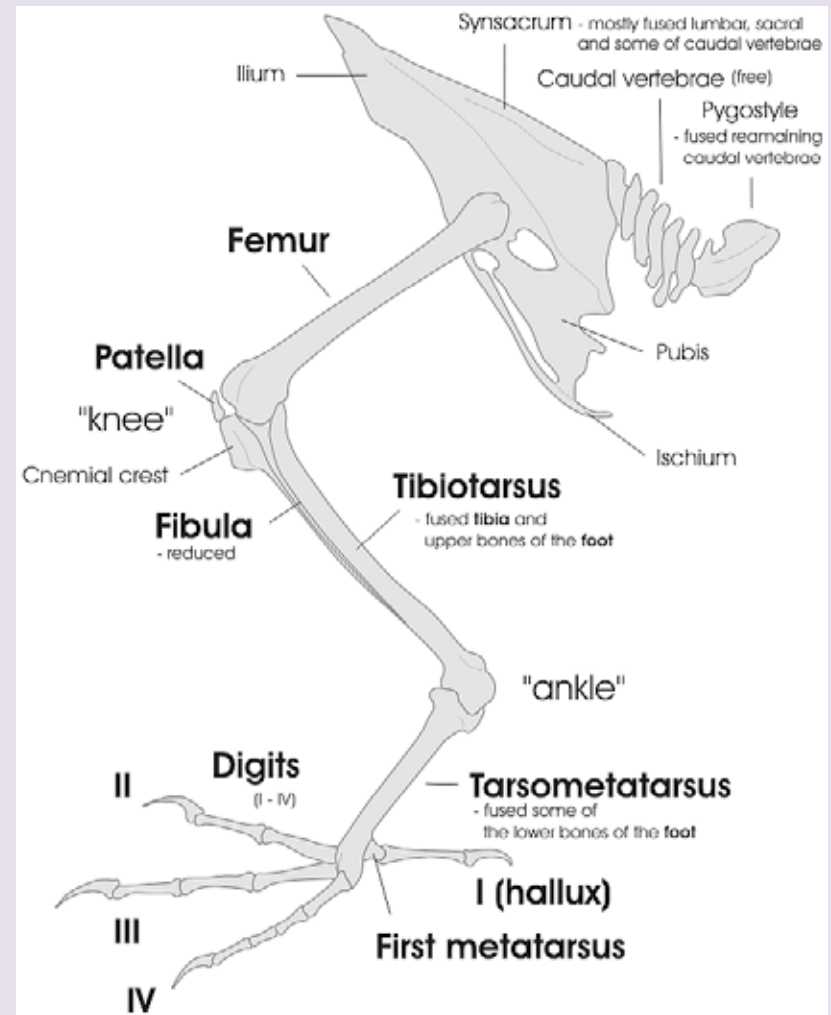
# Pelvis & Synsacrum Notes

- **Turkey/Chicken:** Narrow then wide, not a triangle. Has “pockets” inside—not in goose/duck.
- **Goose/Duck:** Triangular (pubis is the long thin projection and it’s curvy).
- **Owl/Hawk:** Look like “car seats.” Very similar to one another. Owl is a bit wider than hawk. Flat area on ventral surface is wider in owl. Hawk has 2 foramina on dorsal surface at bottom.
- **Crow/Blue Jay:** BJ has little “pockets” inside like turkey/chicken. Posterior surface has 2 troughs. Crow looks same, but larger.
- **Pigeon:** Very square shape. Unique.



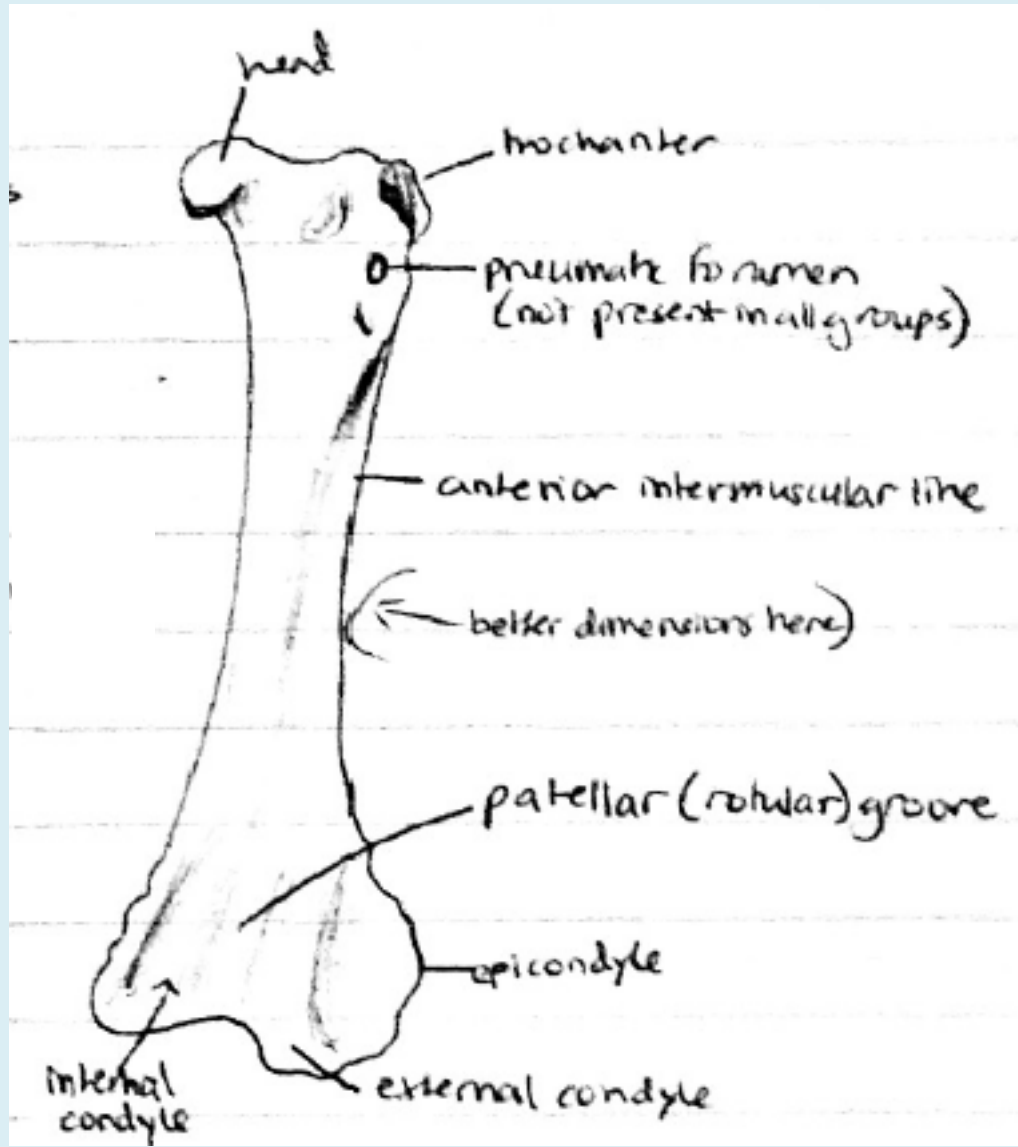
# Lower Limb

- Femur
- Tibiotarsus
- Fibula
- Tarsometatarsus
- Phalanges
  - Digits 1-4
- Claws

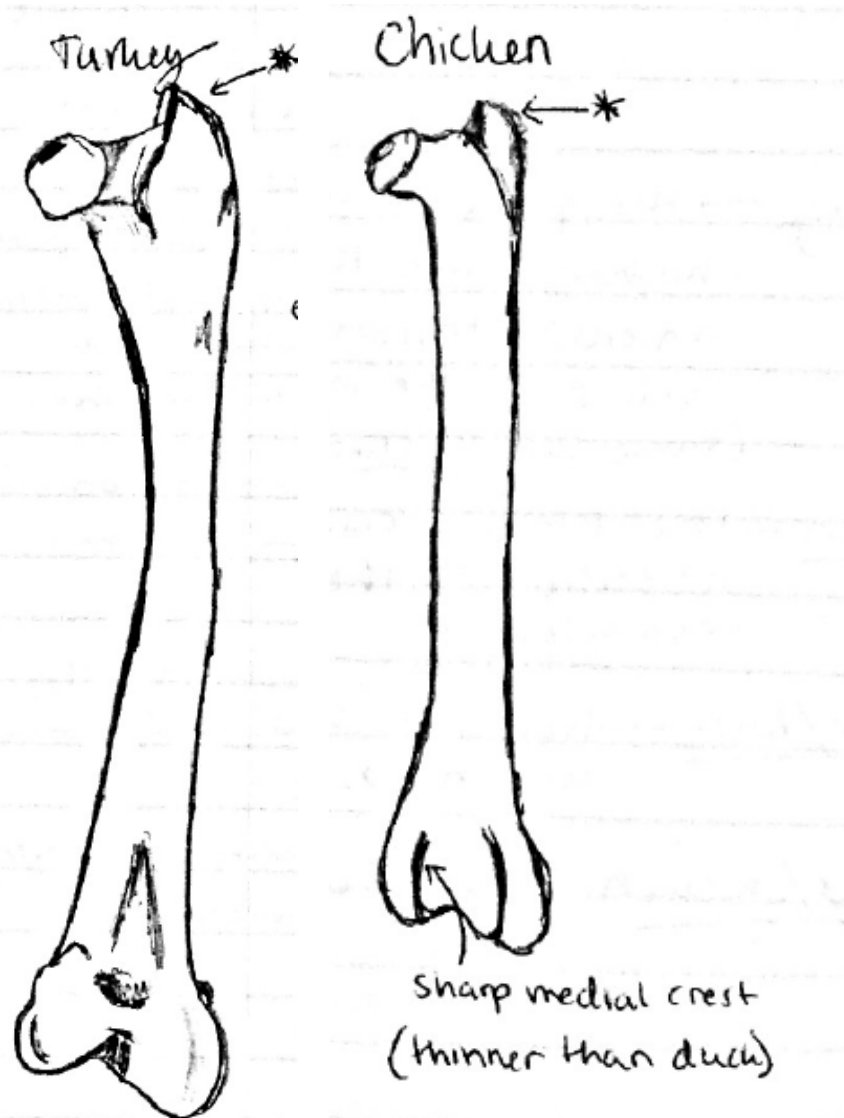




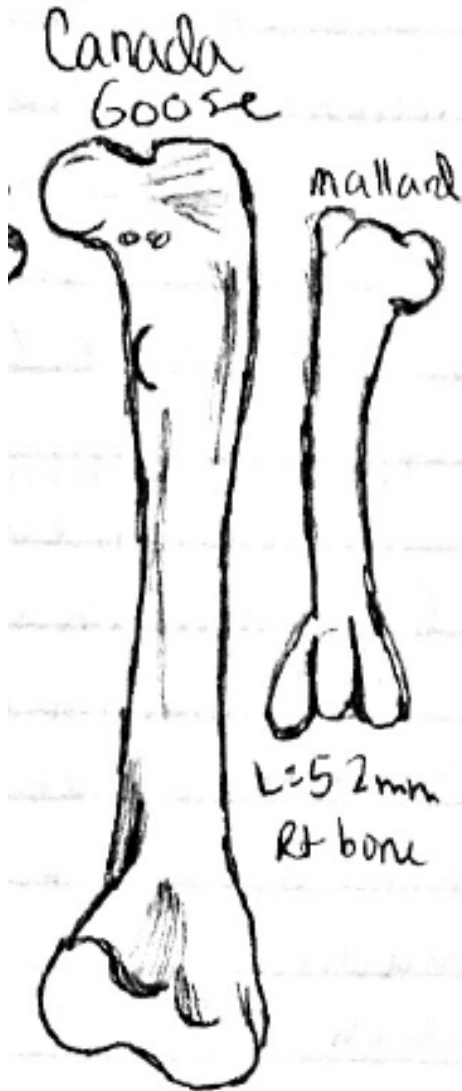
# General Femur



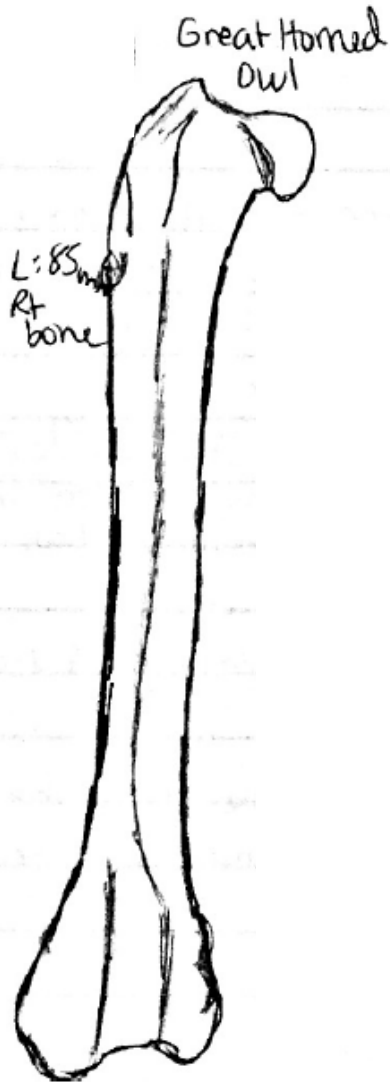
# Femora: Turkey & Chicken



# Femora: Duck & Goose

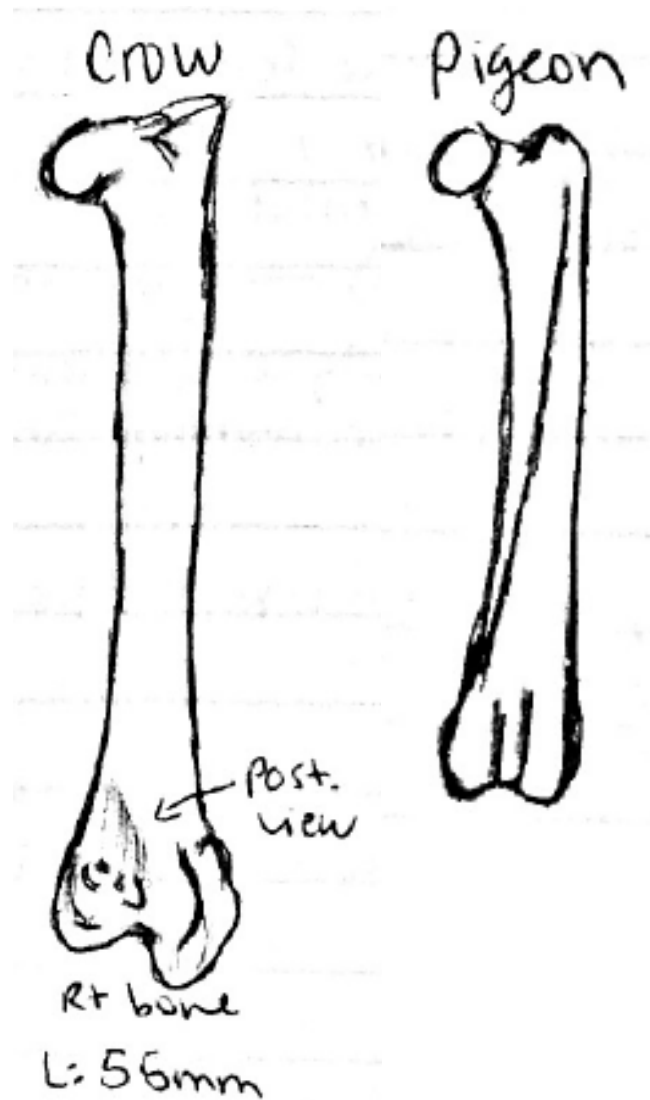


# Femur: Owl & Hawk



Hawk

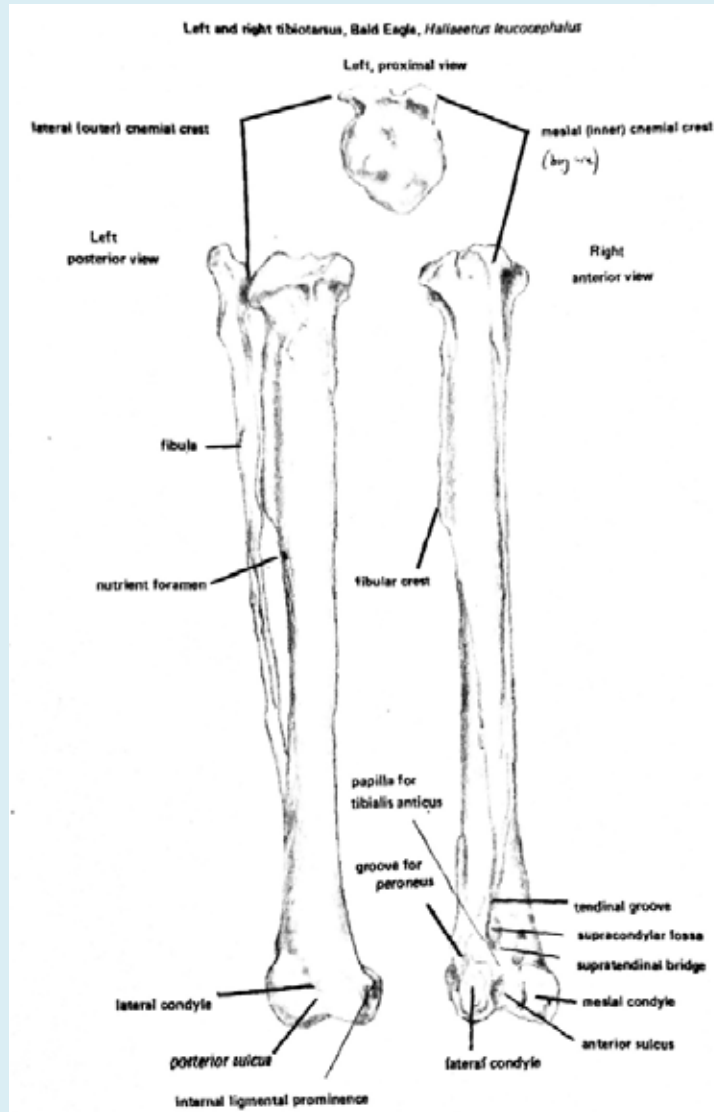
# Femora: Crow & Pigeon



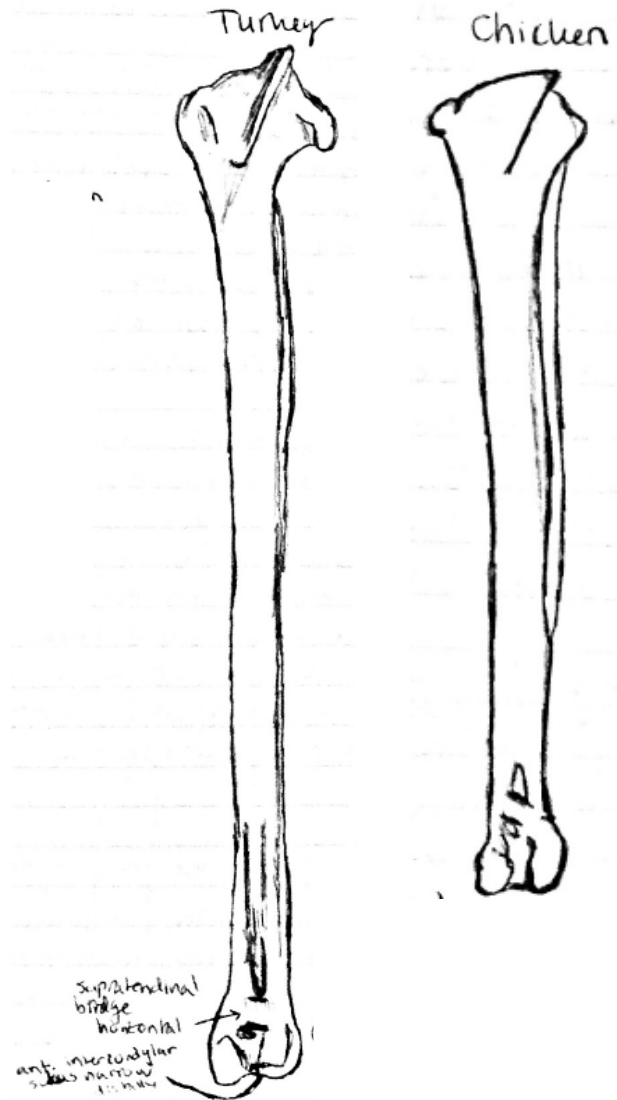
# Femur Notes

- **Turkey/Chicken:** Sharp edge on medial condyle—goose doesn't have (duck slight). Femoral greater trochanter higher up than head. Turkey—shaft also flattened anteroposteriorly and lateral condyle extends distally well past the medial condyle. Same with chicken—not as much in goose/duck.
- **Goose/Duck:** Very short compared to rest of body. Patellar surface wide and deep. Fibular condyle small, ridge-like and doesn't parallel the external condyle. Femoral head more on same level as trochanter. Sharp ridge on back side. Goose much shorter than turkey. Goose about same size as chicken. Duck smallest.
- **Owl/hawk:** Fovea capitis deeper in owl. Crest down anterior shaft. Condyles ~ same level. Trochanter and head same level. Hawks—foramen on anterior aspect (pneumatic foramen).
- **Crow/Blue Jay:** Greater trochanter and head on same level. Looks like play-dough mushed onto the end. Hole above lateral condyle—the lateral condyle is noticeably inferior. Fibular condyle well-developed and there's a large, rounded muscle attachment just proximal to it. There's a pit which may contain foramina, just distal to the iliac facet.
- **Pigeon:** In doves and pigeons, the internal condyle is slightly swollen in distal view and it extends further anteriorly than does the external condyle. Head and neck are continuous, but the greater trochanter projects superiorly unlike in crow/BJ. Popliteal surface on posterior distal end has slight projection.

# General Tarsometatarsus



# Tibiotarsi: Turkey & Chicken

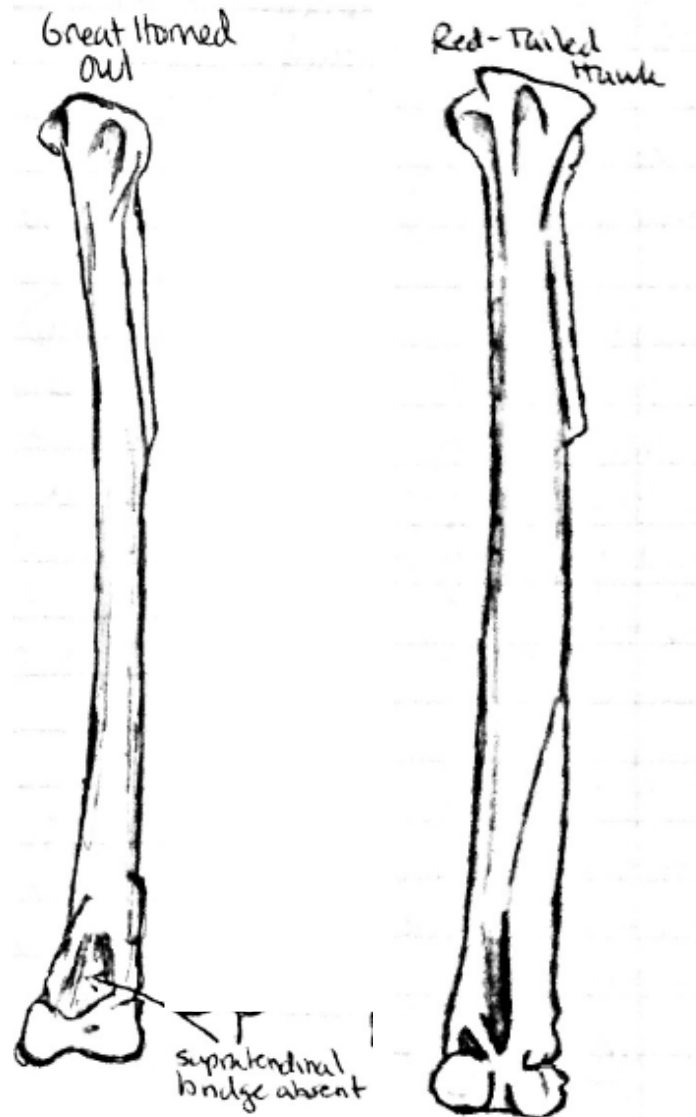




# Tibiotarsus: Duck



# Tibiotarsi: Owl & Hawk



# Tibiotarsus: Pigeon



# Tibiotarsus Notes

- **Turkey/Chicken:** Slightly more diagonal supratendinal bridge. More robust. Less prominent crest traveling down proximal distal shaft than goose. Chicken—more obvious diagonal supratendinal bridge.
- **Goose/Duck:** Mesial cnemial crest resembles a “potato chip.” Supratendinal bridge horizontal. Lateral cnemial crest not as hooked as turkey. Smaller foramina more posterior than turkey. Thinner and shorter too. Proximal distal “trough.” Duck—mesial cnemial crest projects anteriorly more than in many other groups. Inside view, tibiotarsal shaft very straight. Intercondylar sulcus broad and shallow. Distal foamen of supratendinal bridge is nearly centered above the anterior intercondylar sulcus.
- **Owl/Hawk:** Supratendinal bridge—hawk ~ 45 degrees, so more diagonal than chicken. Hawk is compressed anteroposteriorly. Owl does NOT have supratendinal bridge.
- **Crow/Blue Jay:** Supratendinal bridge horizontal. Condyles round.
- **Pigeon:** Round condyles. More triangular mesial cnemial crest. Diagonal supratendinal bridge. Fibular crest short—less than 1/3 length of shaft. Internal condyle (opp. Fibular crest) is rounded.

# General Tarsometatarsus

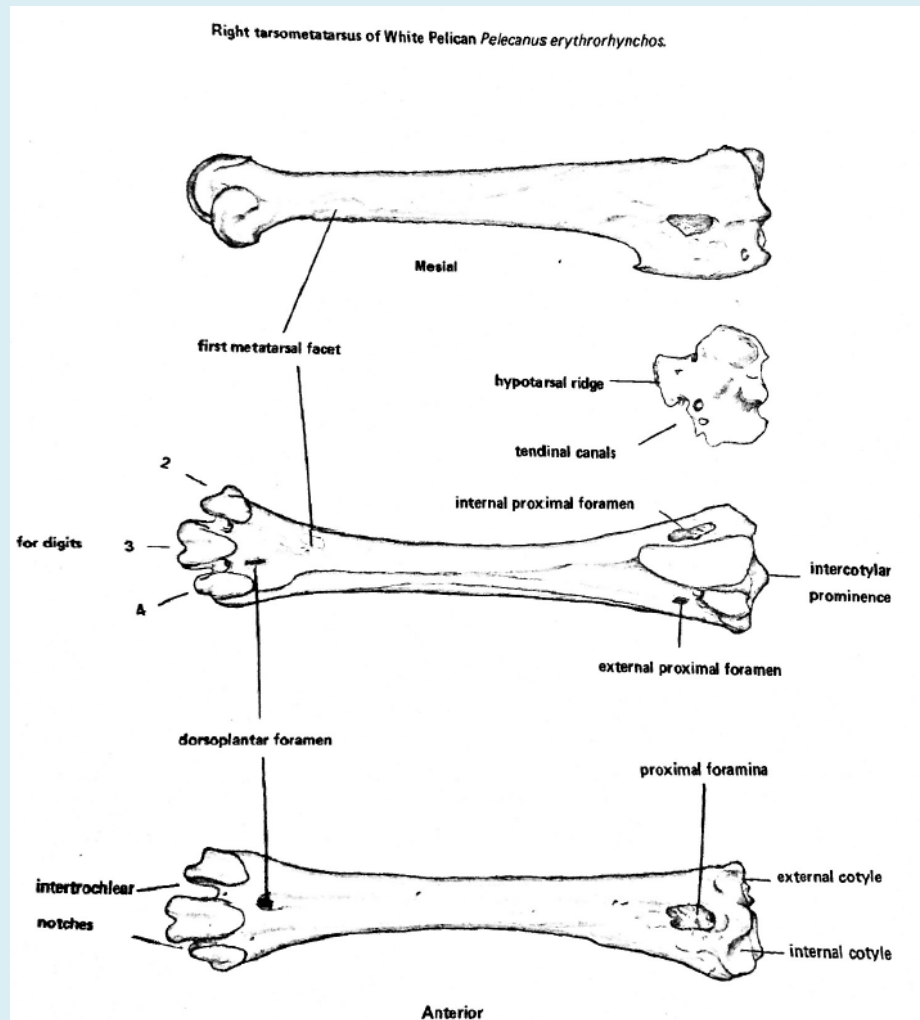


Figure 82.

# Tarsometatarsus Notes

- **Turkey/Chicken:** 1 tendinal canal on proximal end. Trochlea for digits on mesial and lateral ends more on same level. Shorter/smaller dorsoplantar foramen than goose/duck.
- **Goose/Duck:** Digit trochlea opposite dorsoplantar foramen more elevated and pulled posterior. Looking down on proximal end—there are 2-2 ½ tendinal canals visible.
- **Owl/Hawk:** 2 crests on posterior surface making posterior side more tubular/arched. All 3 toes on same level unlike goose/duck/turkey/chicken. More even in hawk than owl. Proximal ends of both hawk and owl very unique. Hawk more flattened and confined to a rectangular shape. Owl looks more like an owl face—2 big eyes with tufts. Owl also has supratendinal crest crossing over anterior proximal surface, 2 larger foramen on posterior view (hawk has 2 tiny ones).
- **Crow/Blue Jay:** Medial trochlea (digit) is divergent—projects away from other trochlea. But toes still on same level. 4 tendinal canals, but button-shaped.
- **Pigeon:** Proximal end has 2 tendinal canals. Toes no longer on same level. Outside ones more elevated and trochlea opposite dorsoplantar foramen is at same level as the opposite end, but pushed back more posteriorly.



# References

- Anatomical notes and general bone information from *Avian Osteology*. Great book if you are interested in North American birds!
  - Gilbert BM, Martin LD, Savage HG. 1981 *Avian Osteology*. Columbia: Missouri Archaeological Society.
  - [http://www.royalbcmuseum.bc.ca/Natural\\_History/Bones/homepage.htm](http://www.royalbcmuseum.bc.ca/Natural_History/Bones/homepage.htm)
- A highly recommended book to own:
  - Elbroch M. 2006 *Animal Skulls: A Guide to North American Species*. Mechanicsburg: Stackpole Books.