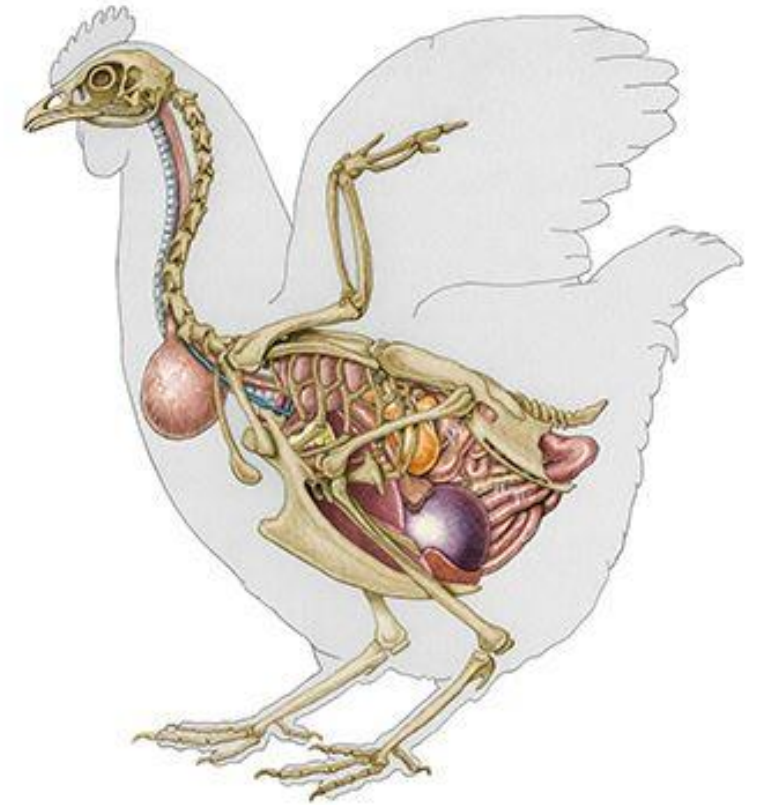
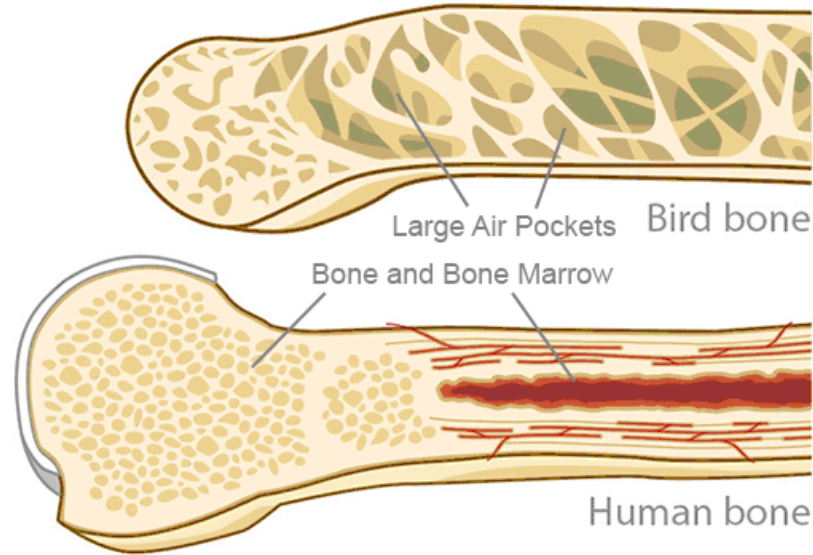
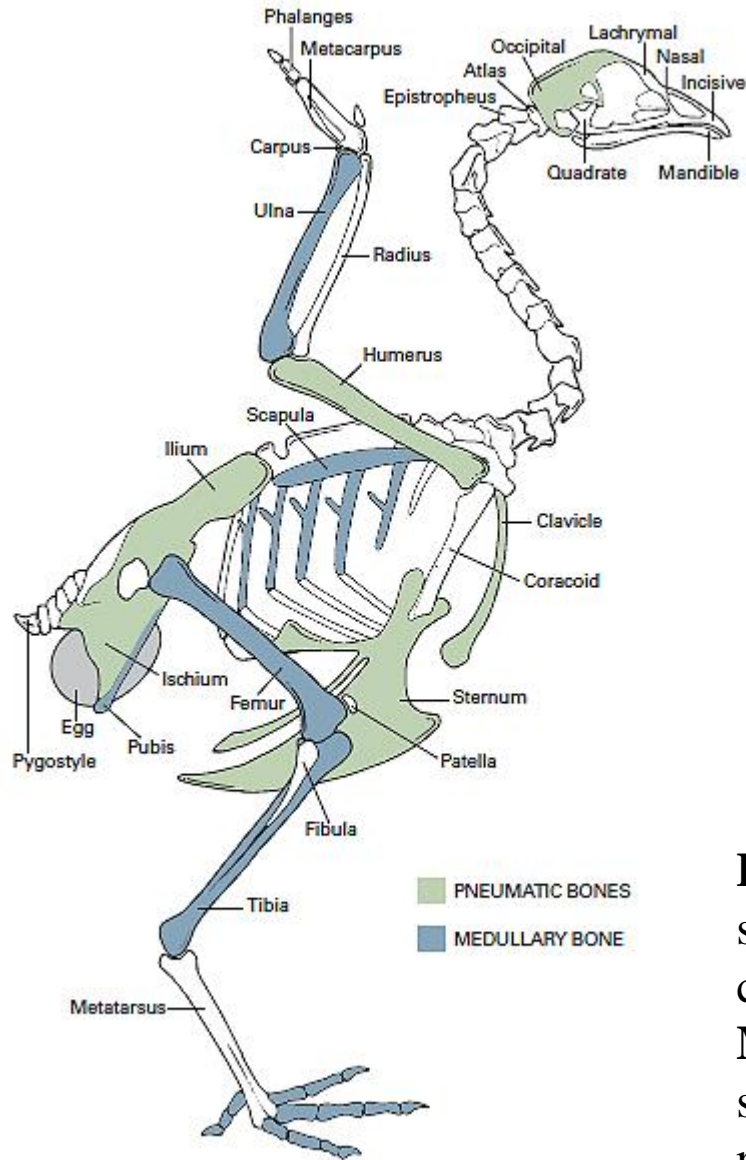


ANATOMY OF BIRDS



BONES

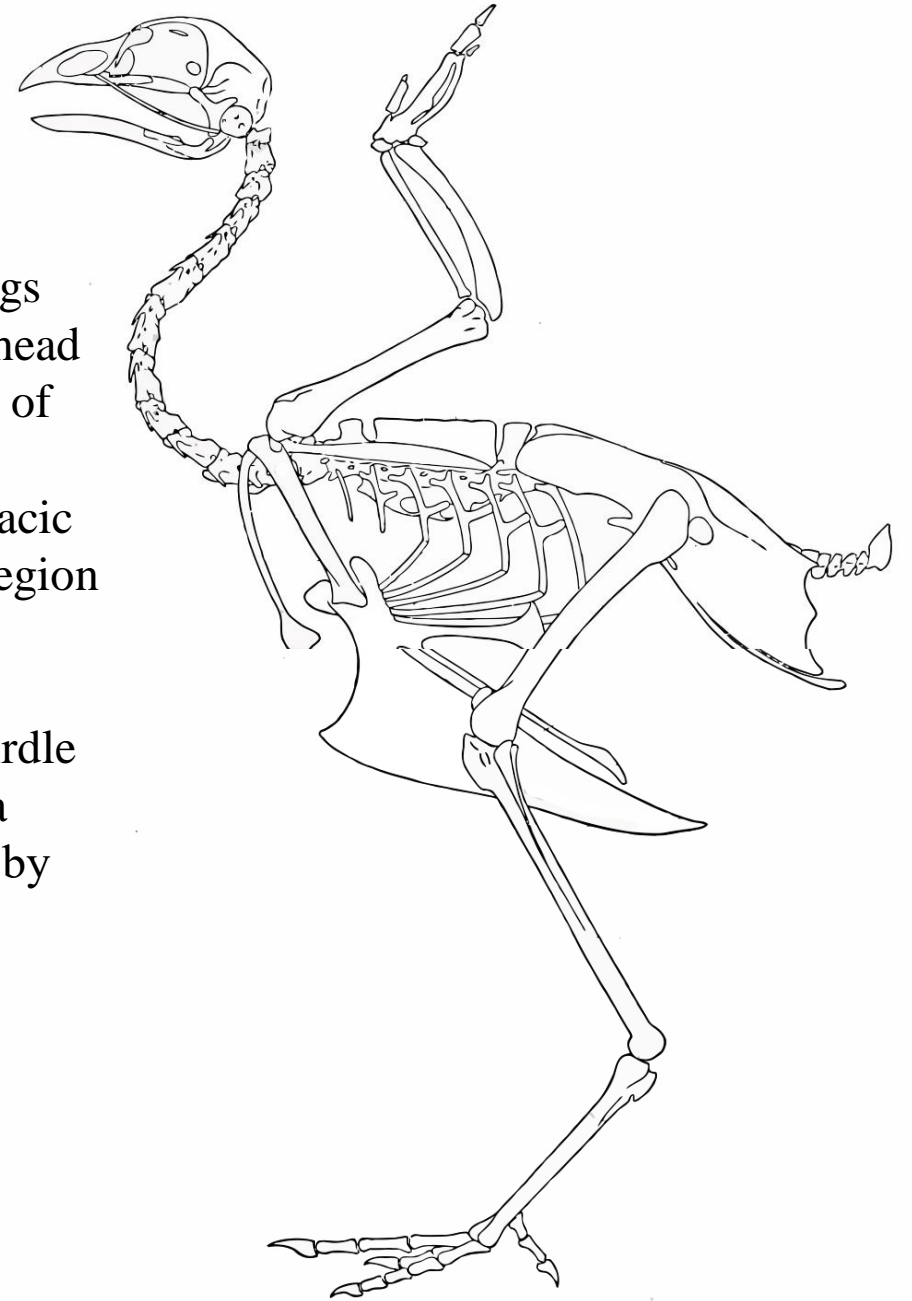
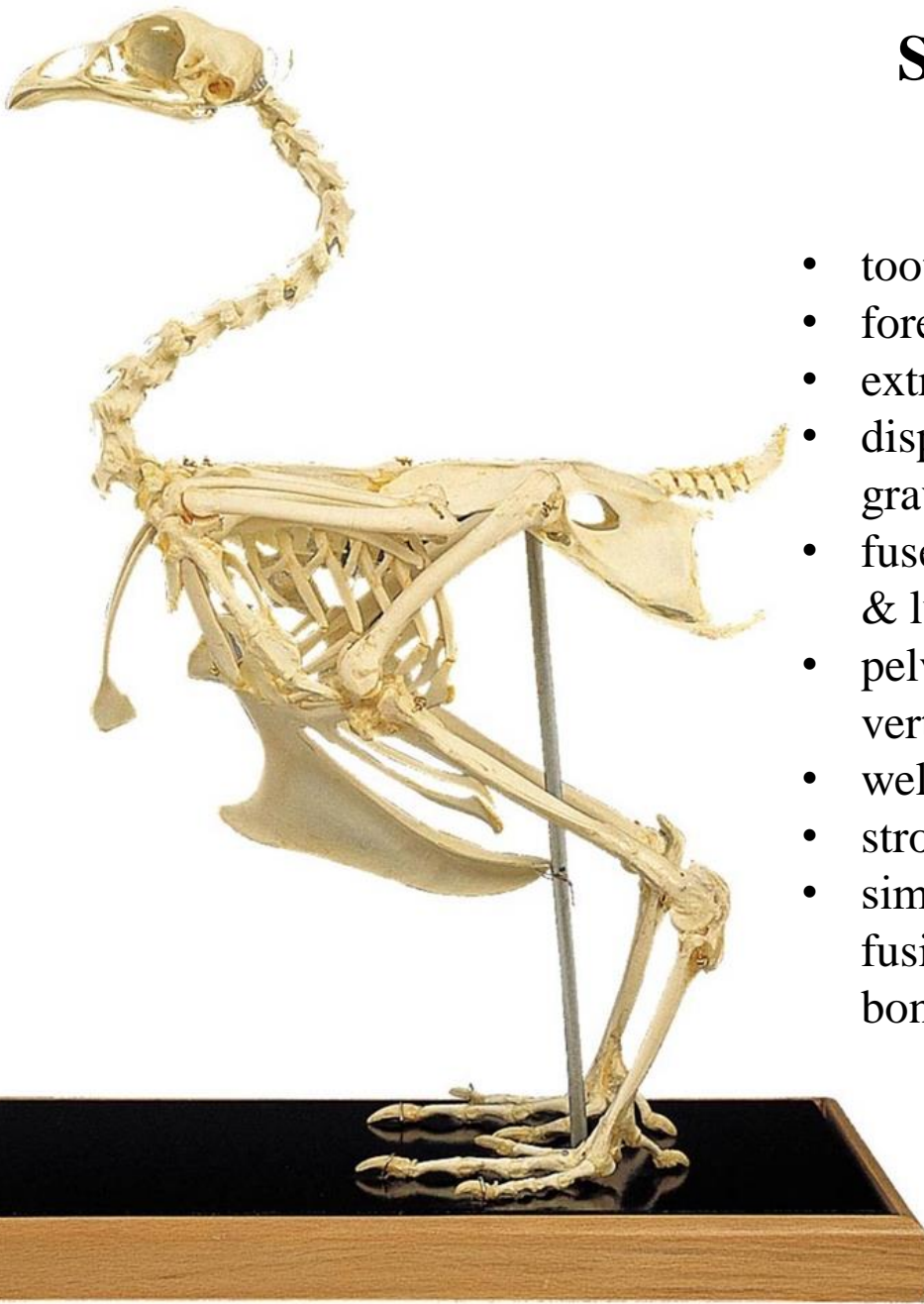


Pneumatic bones – Hollow and air-filled, these bones are part of the respiratory system and help with flying. The bones are held together by thin bar-like structures called struts, which prevent the bones from collapsing.

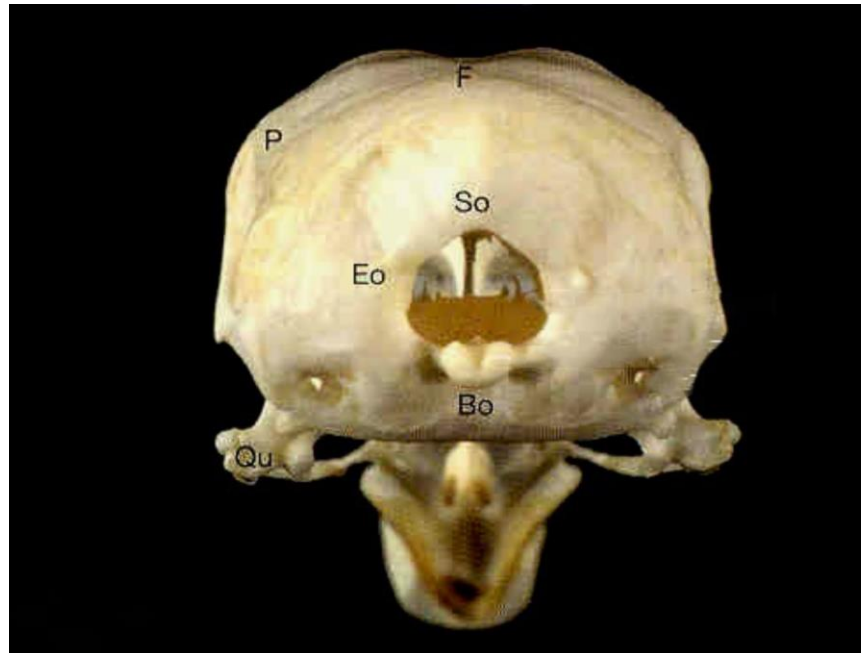
Medullary bone – This specialised bone is used as a source of calcium for the egg shell for laying hen and only occurs in birds and some reptiles. Easily created and resorbed, medullary bone is ideally the first source mobilised when more calcium is required.

SCELETON

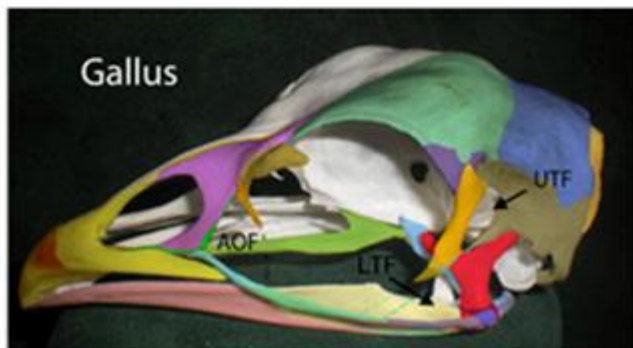
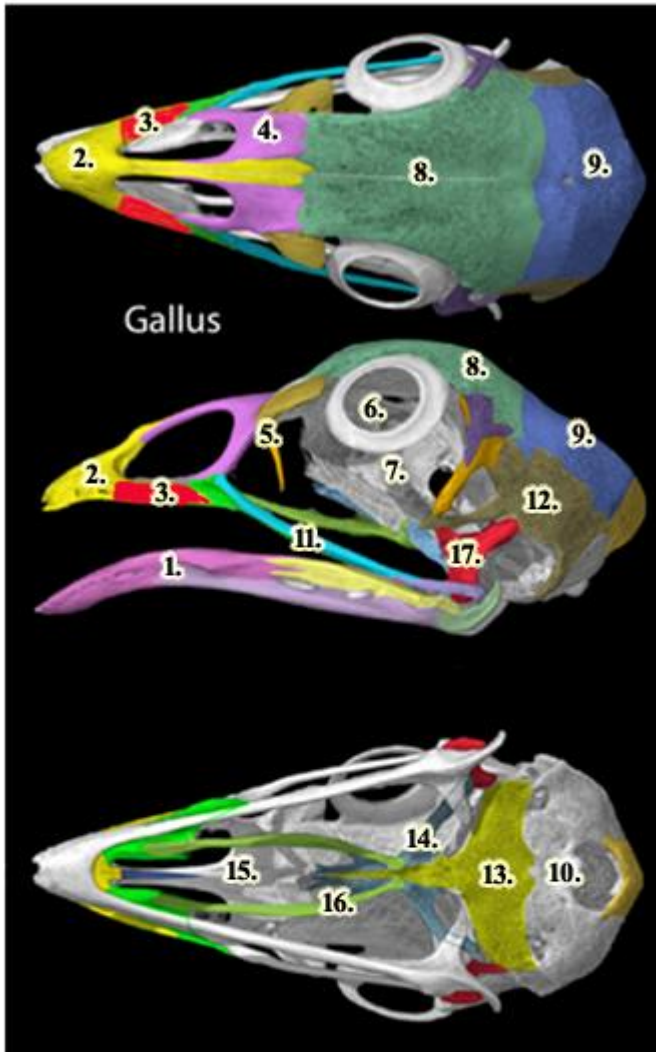
- toothless horny beak
- forelimbs modified as wings
- extreme mobile neck and head
- displacement of the center of gravity
- fused vertebrae at the thoracic & lumbosacral & caudal region
- pelvis is fused with the vertebral column
- well developed thoracic girdle
- strong sternum with carina
- simplified limb's skeleton by fusions & eliminations of bones.



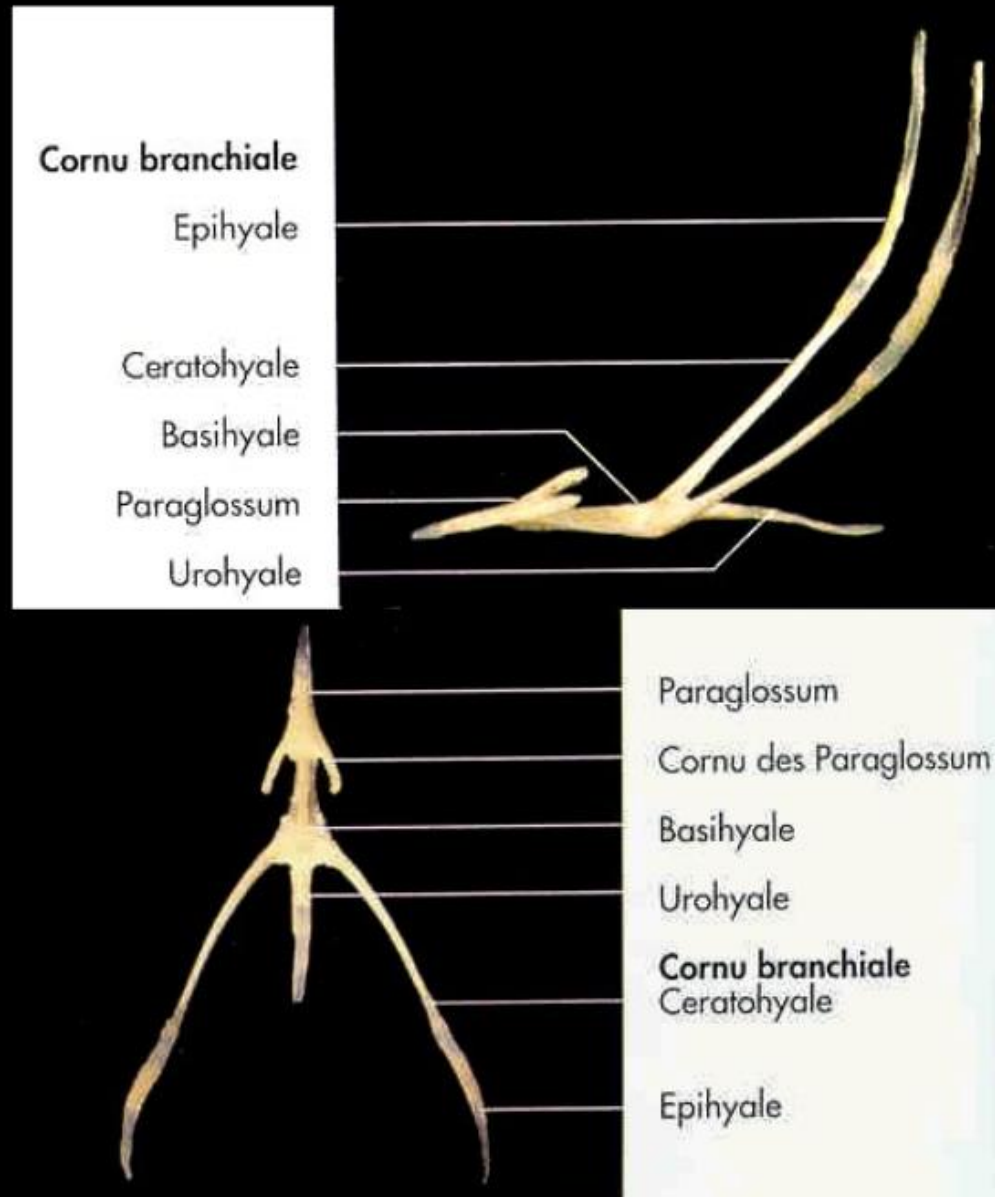
SCULL



1. Mandibula
2. Os premaxillare
3. Maxilla
4. Os nasale
5. Os lacrimale
6. Orbita
sclerotic ring
7. Septum interorbitale
8. Os frontale
9. Os parietale
10. Os occipitale (supra-, basi-, exoccipital)
11. Os jugale
12. Os squamosum
fossa tympanica
13. Os sphenoidale
14. Os pterygoidale
15. Vomer
16. Os palatinum
17. Os quadratum



HYOID BONE



VERTEBRAL COLUMN

Chicken:

C: 14

Th: 7

L+S: 14

C: 7

Cervical vertebrae

Notarium

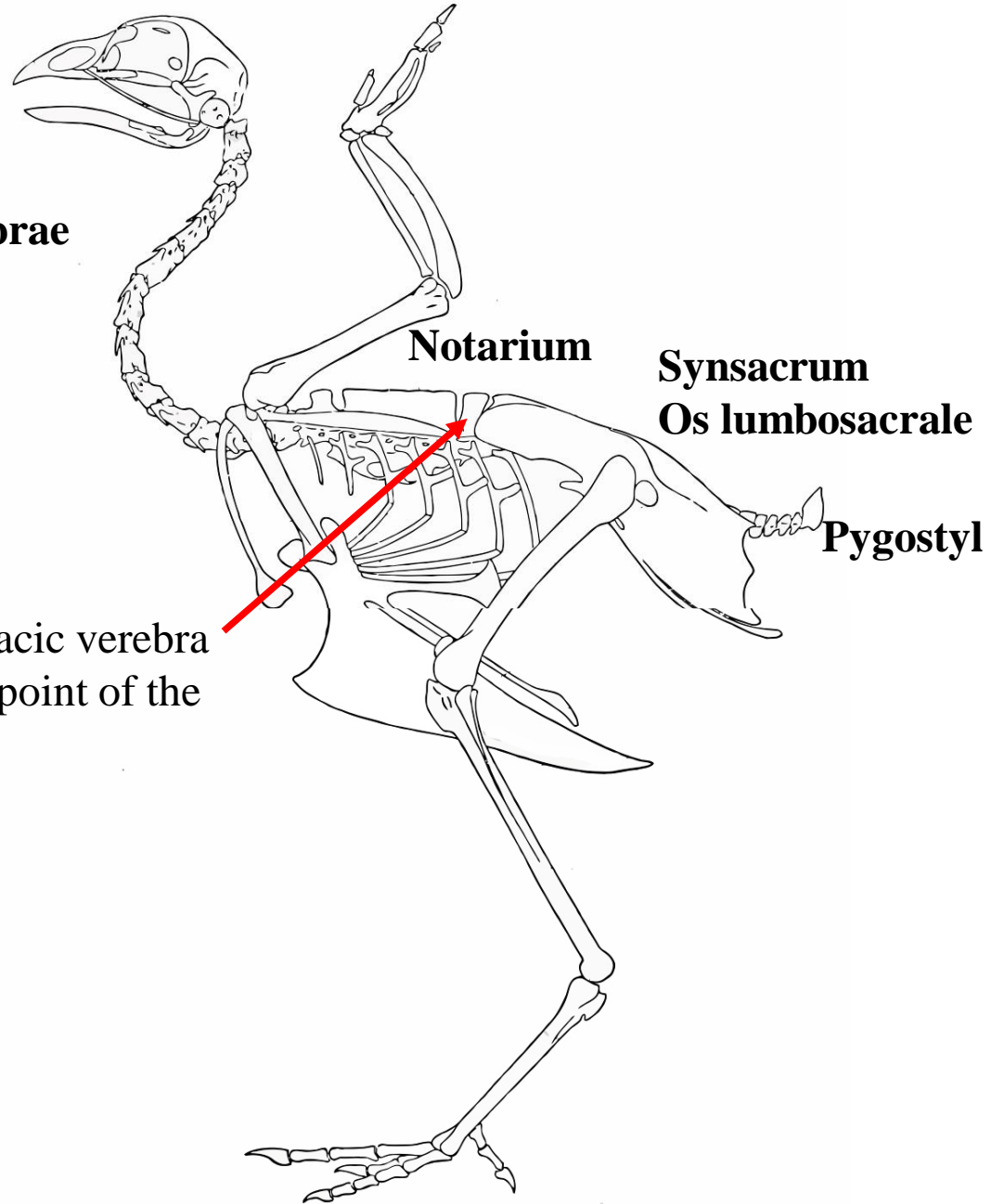
Synsacrum

Os lumbosacrale

Pygostyl

Single free thoracic vertebra
(6th), the weak point of the
column

Different from mammals: most of the joints between the vertebral bodies (which are not fused) are synovial joints having a meniscus.

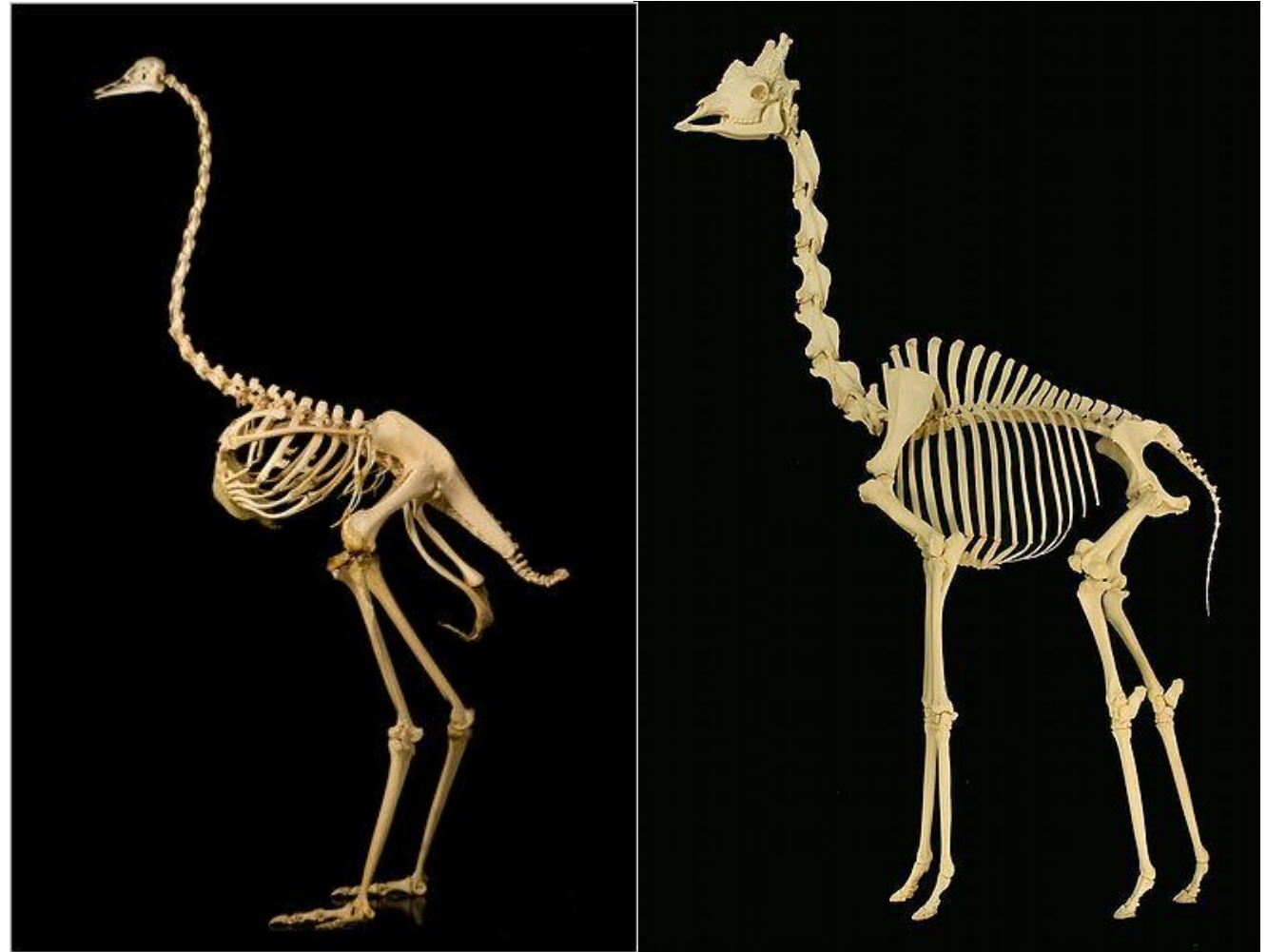
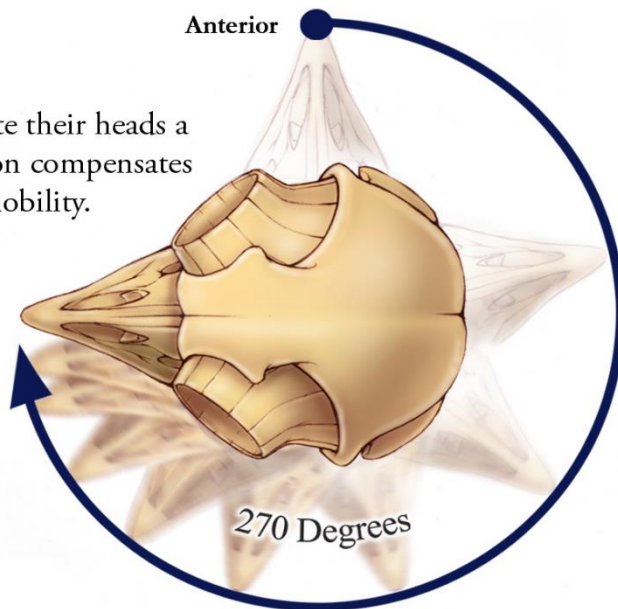


CERVICAL VERTEBRAE

- number varies between 8-25 (chicken: 14)
- high mobility at the atlanto-occipital joint & between cervical vertebrae

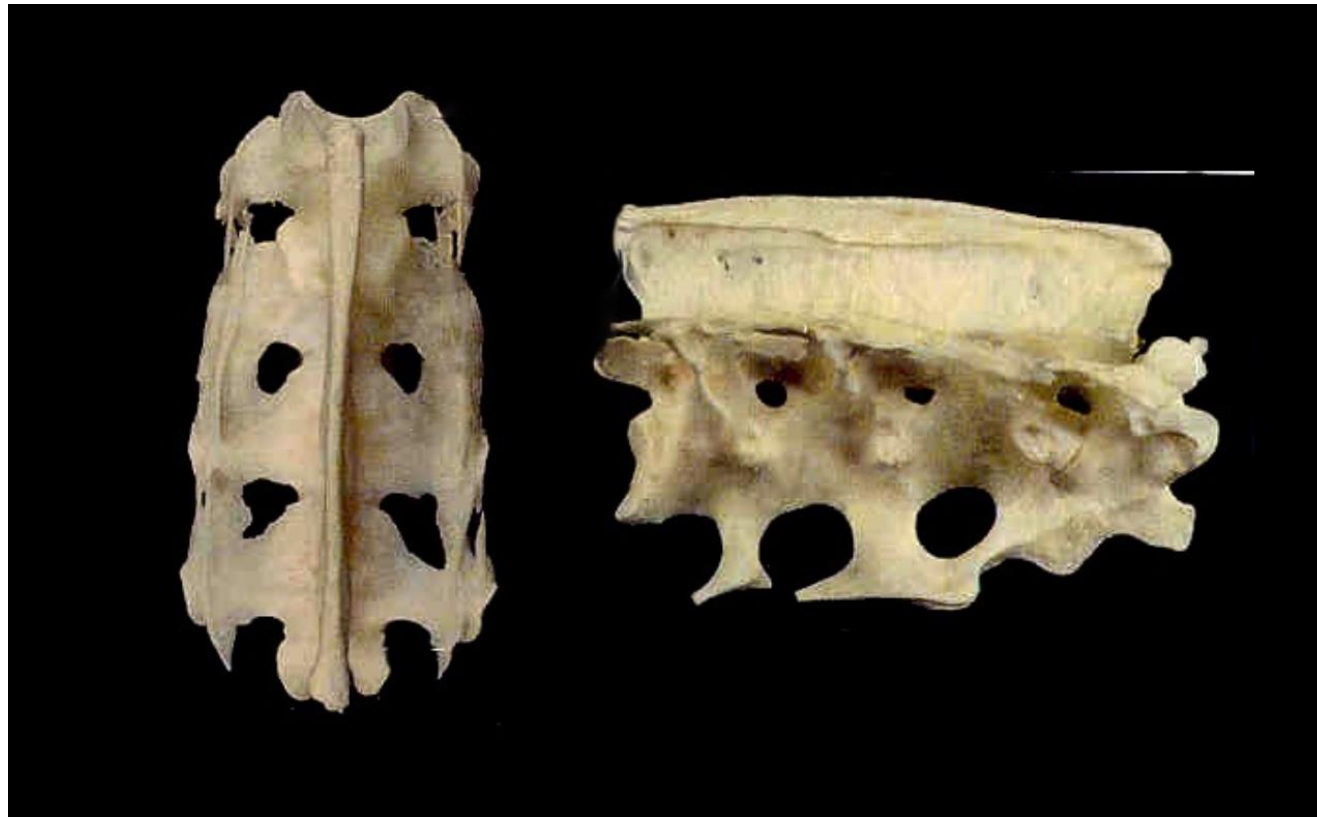


Owls are able to rotate their heads a full 270°. This rotation compensates for their ocular immobility.



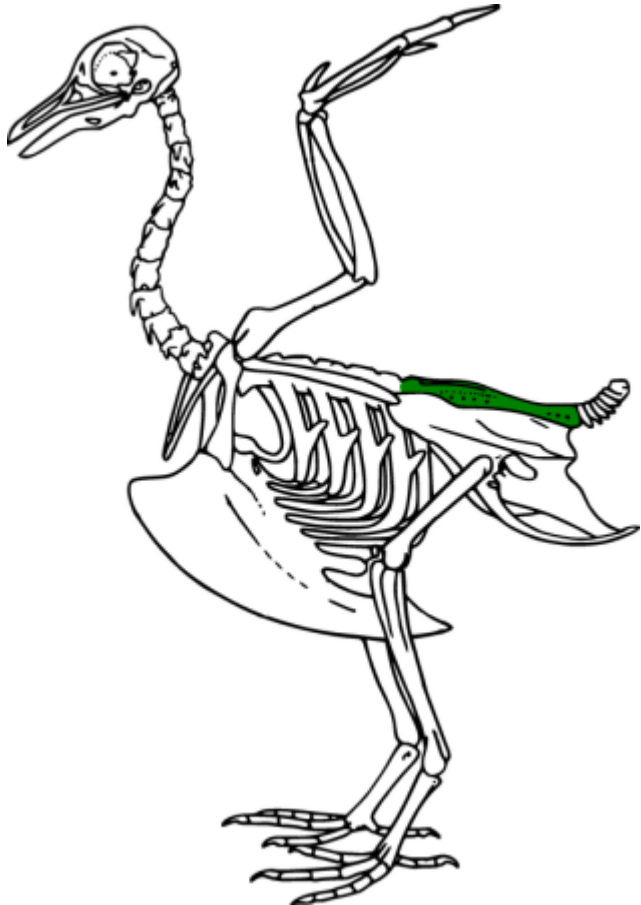
THORACIC VERTEBRAE, NOTARIUM

- number varies between 3-10 (chicken: 7)
- Fused thoracic vertebrae (except goose and duck, where they are free)
- The **notarium** is formed from the 2-5 thoracic vertebrae, and helps provide rigidity in the back when a bird is flapping its wings.
- After one free thoracic vertebra the last thoracic vertebrae are fused to form the **synsacrum**



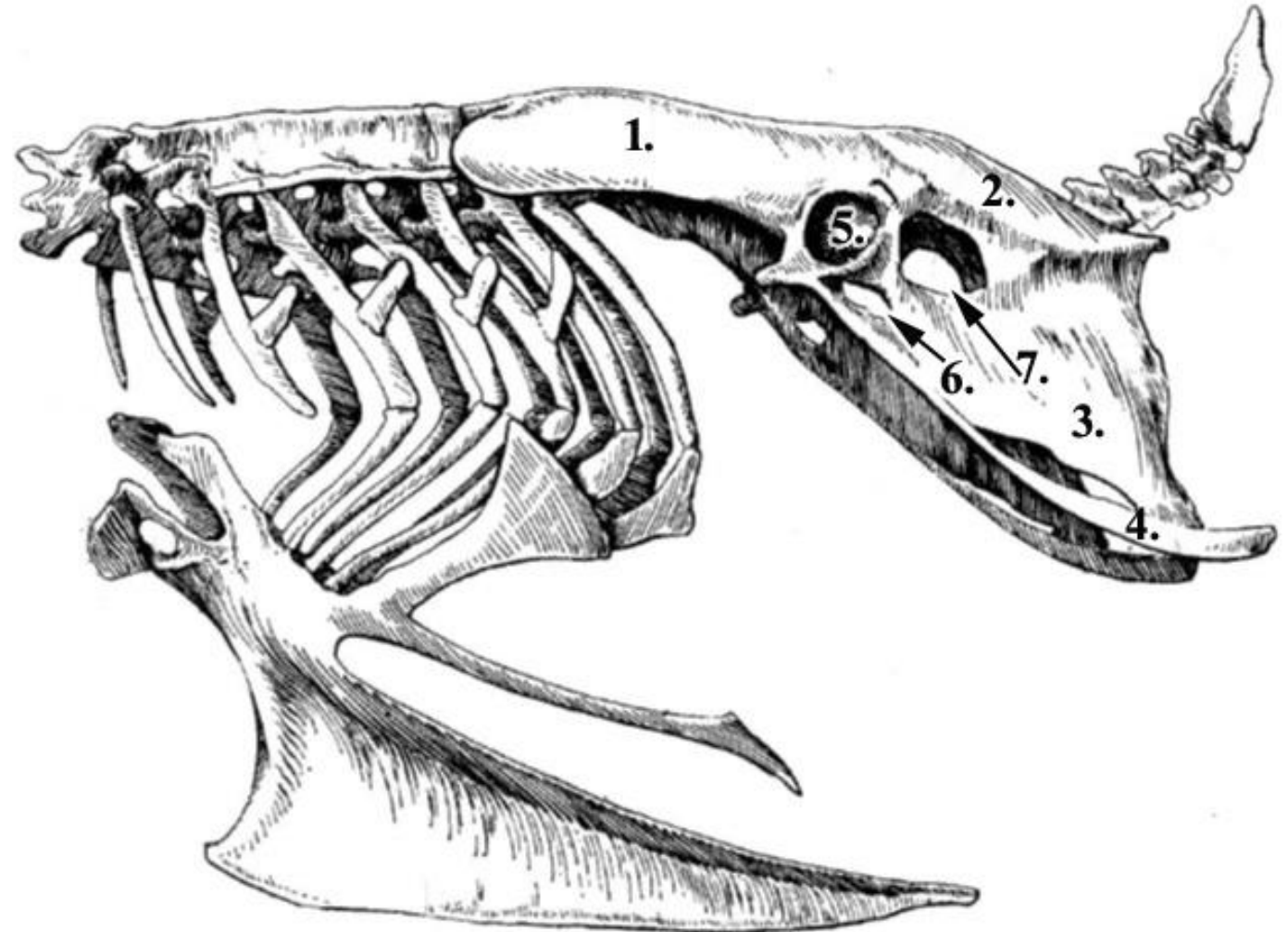
SYNSACRUM, PYGOSTYL

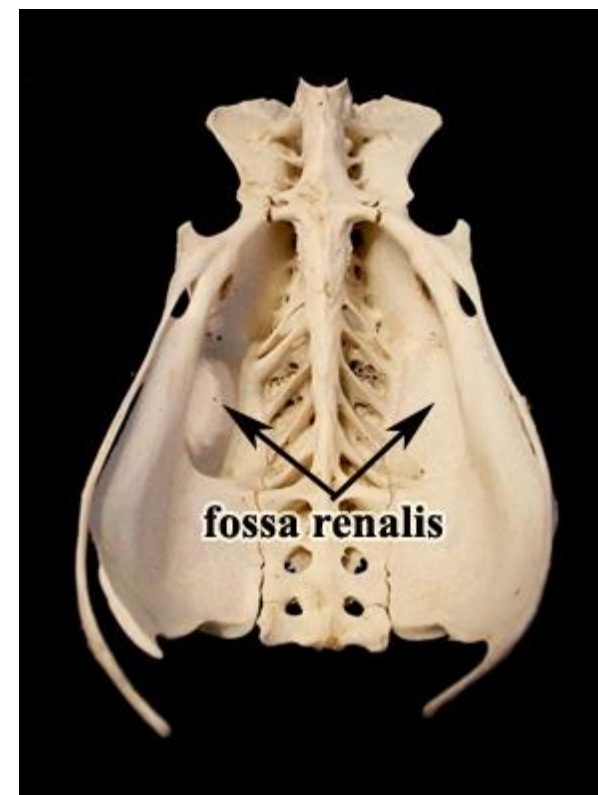
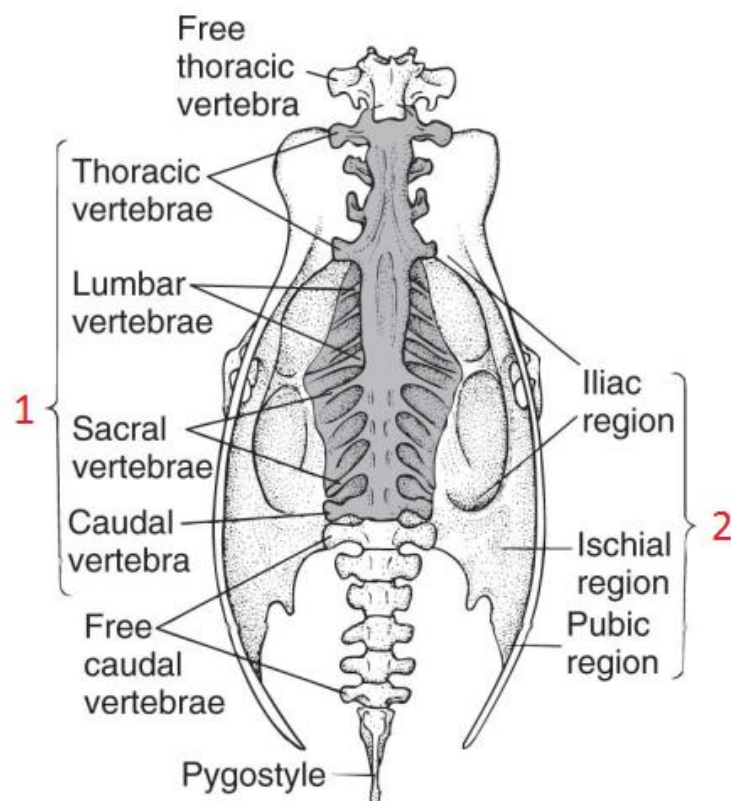
- **Synsacrum** absorbs compression shock whenever the bird lands at high speed, provides support for the independent movement of wings and legs
- fused last thoracic, lumbar, sacral, first caudal vertebrae
- Synsacrum is fused with the pelvis to form **os lumbosacrale**
- The **pygostyl** are the fused and flattened caudal vertebrae that support the tail feathers



PELVIC GIRDLE

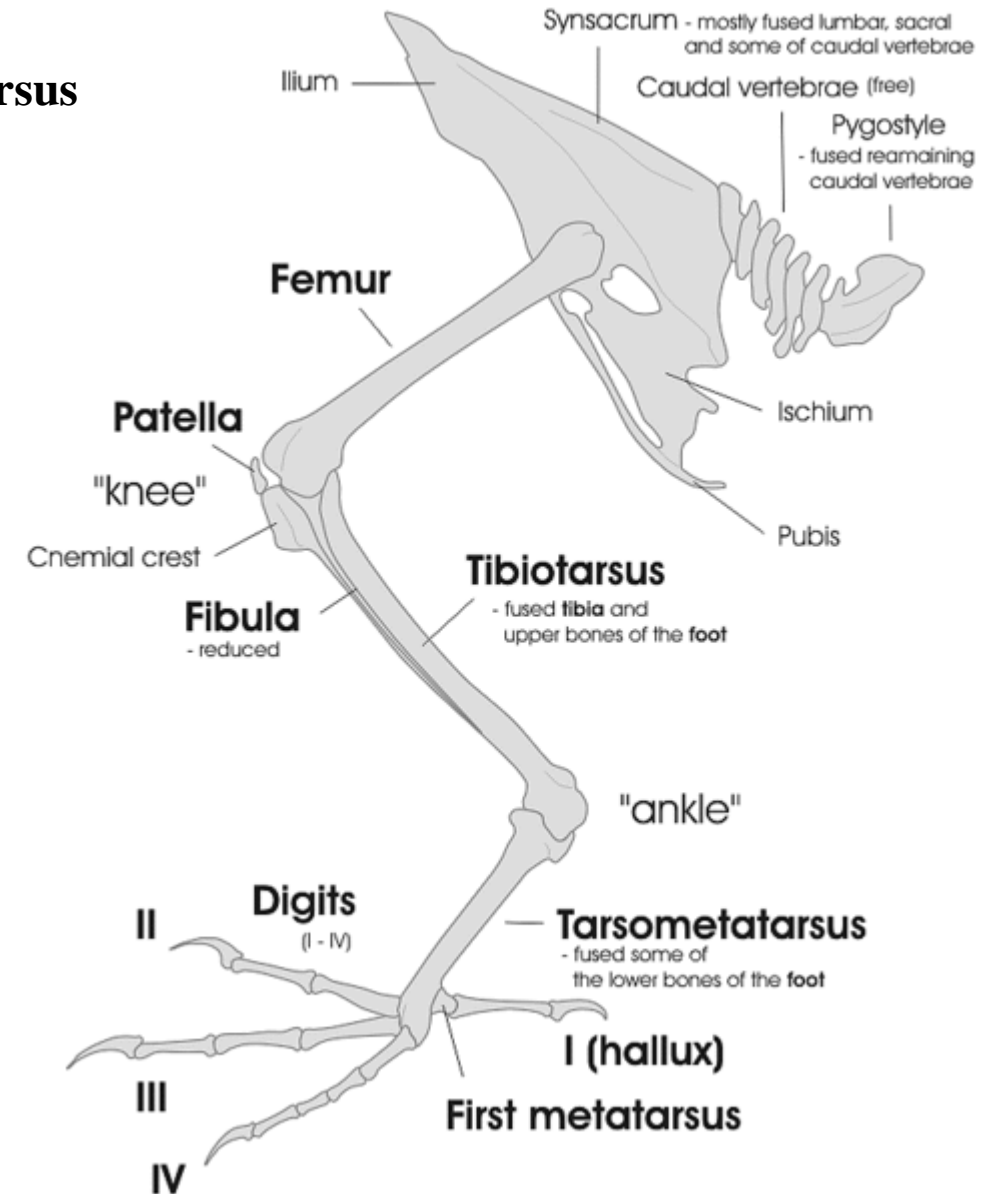
- Pelvic bones are fused with the synsacrum to form the **os lumbosacrale**.
- **Ilium**
 - 1. ala preacetabularis ilii
 - 2. ala postacetabularis ilii
 - antitrochanter
 - fossa renalis
- **3. Ischium**
- **4. Pubis**
- **Acetabulum**
 - 5. foramen acetabuli
 - 6. foramen obturatum
 - 7. foramen ilioischadicum
 - 8. fenestra ischiopubica
- missing symphysis





HINDLIMB

- Hindleg used for body support and locomotion (bipedal walking)
- proximal tarsal bones are fused with the tibia to form the **tibiotarsus**
- distal tarsals are fused with metatarsals (II, III, IV) to form the **tarsometatarsus**
- **digits - only 4**, phalanges – I. digit: 2, II. digit: 3, III. digit: 4, IV. digit: 5



FOOT TYPES



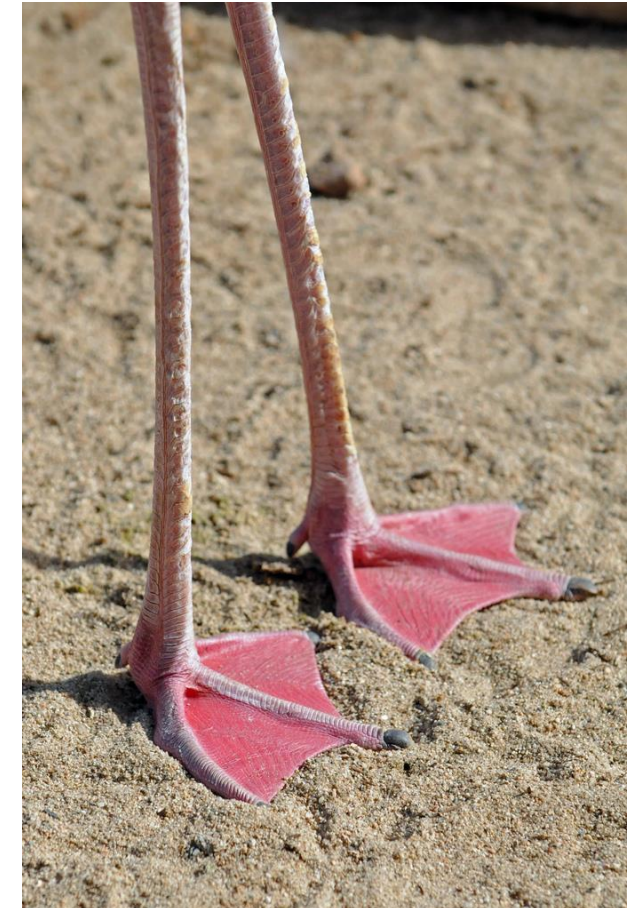
The most common foot design: perching feet, three digits are forward-facing, while the first digit (hallux) faces backward.



The second most common foot formation among birds: four digits, but two digits facing forward and two digits facing backward. This foot is traditionally found on tree-clinging birds like woodpeckers, in parrot species and owls.



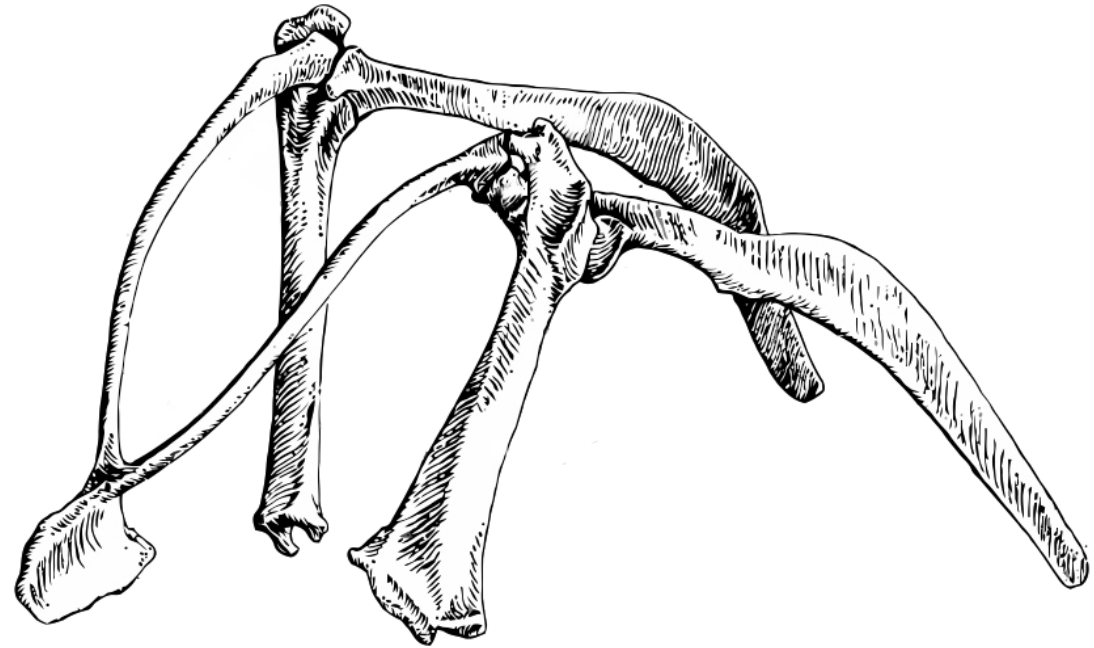
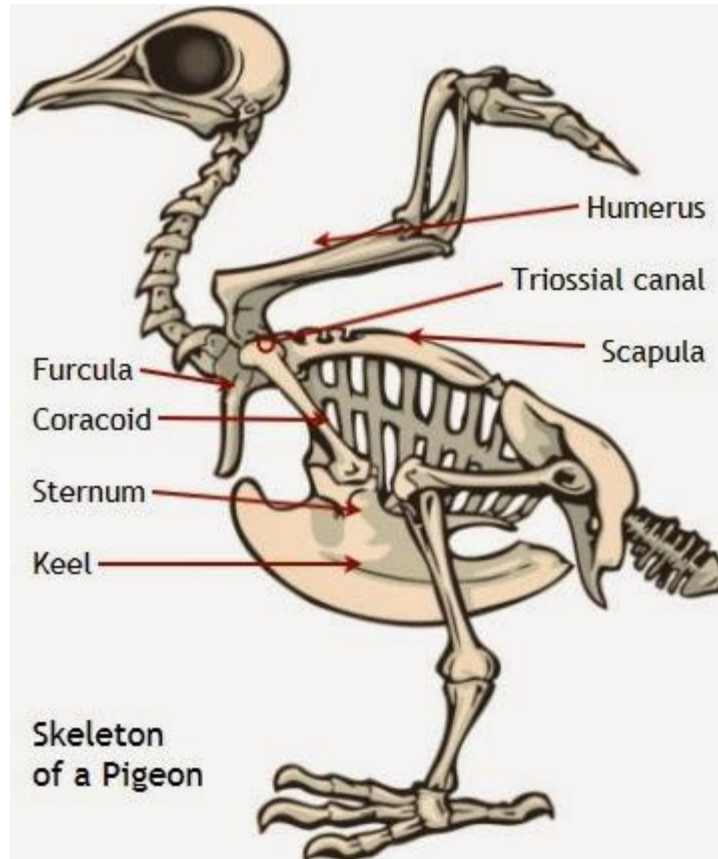
Ostrich: walking and running feet, only two digits.



Flamingo: swimming bird with webbed feet.

THORACIC GIRDLE

- **scapula**
- **os coracoideum and furcula (2 fused clavacula)**- they brace the sternum and prevent the collapse of the chest during the contraction of flight muscles
- **canalis triosseus**



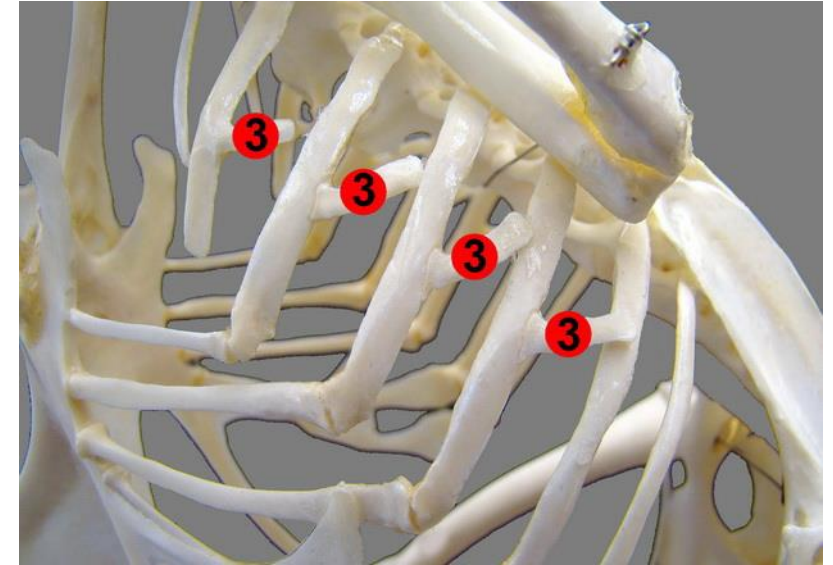
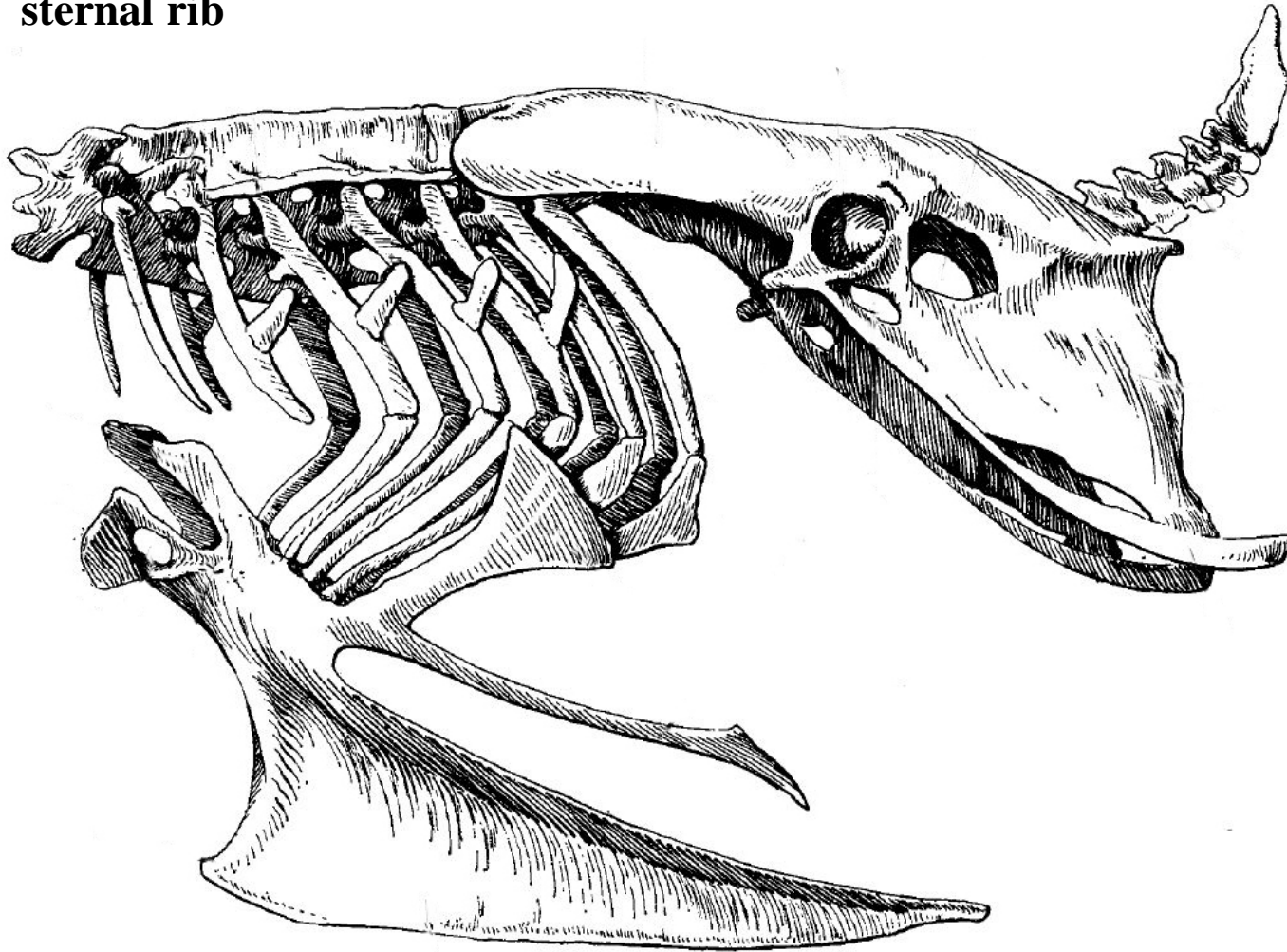
Canalis triosseus



Wishbone

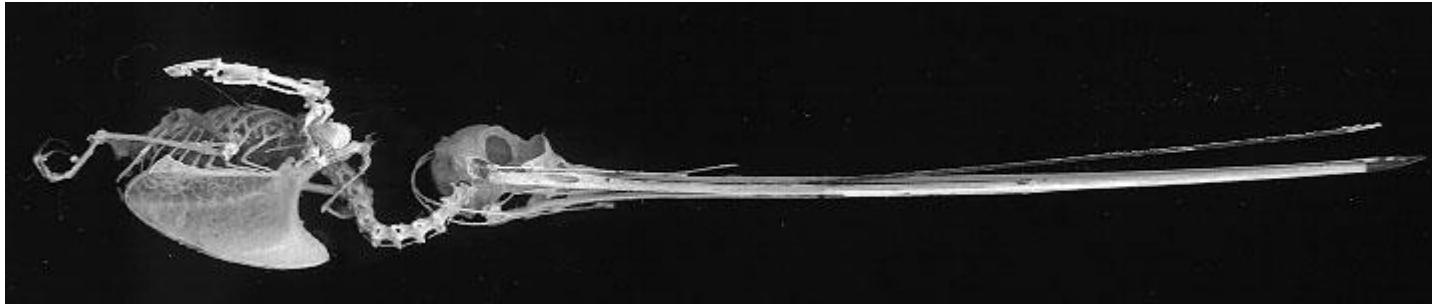
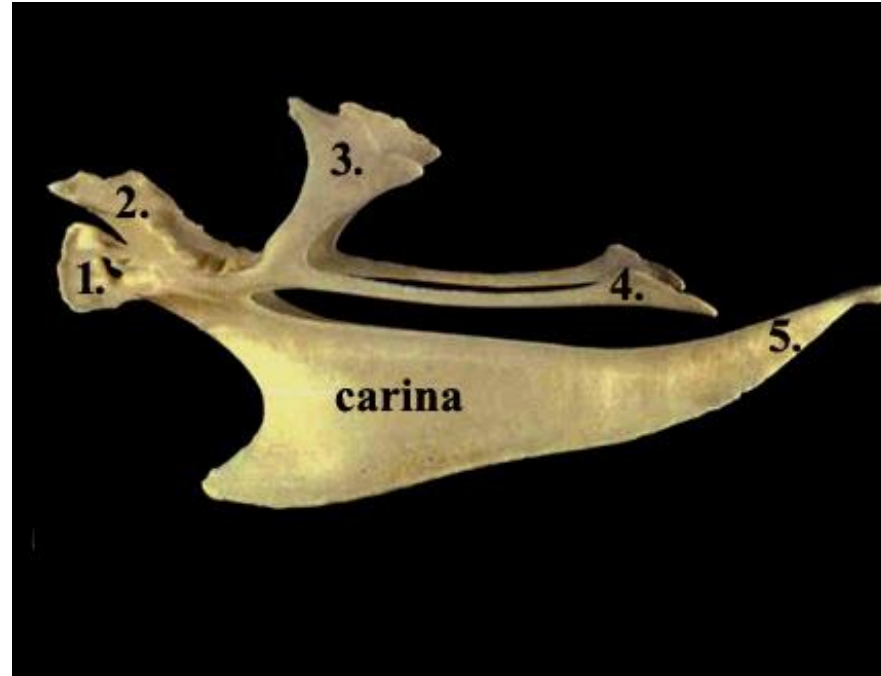
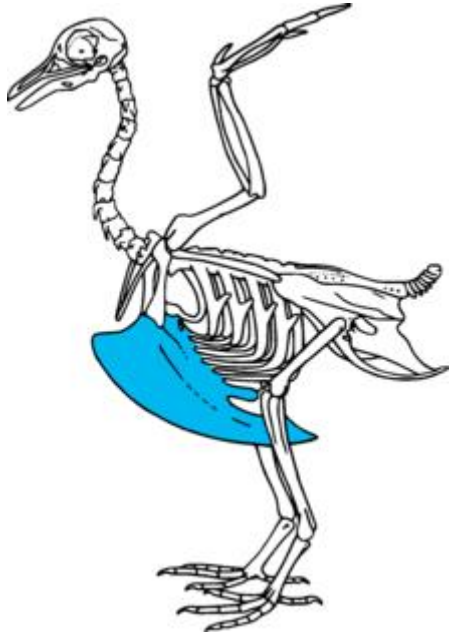
RIBCAGE

- Forming a light, strong cage protecting heart, viscera during the flight
- **vertebral rib**
overlapping **processus uncinatus (3)**
- **sternal rib**

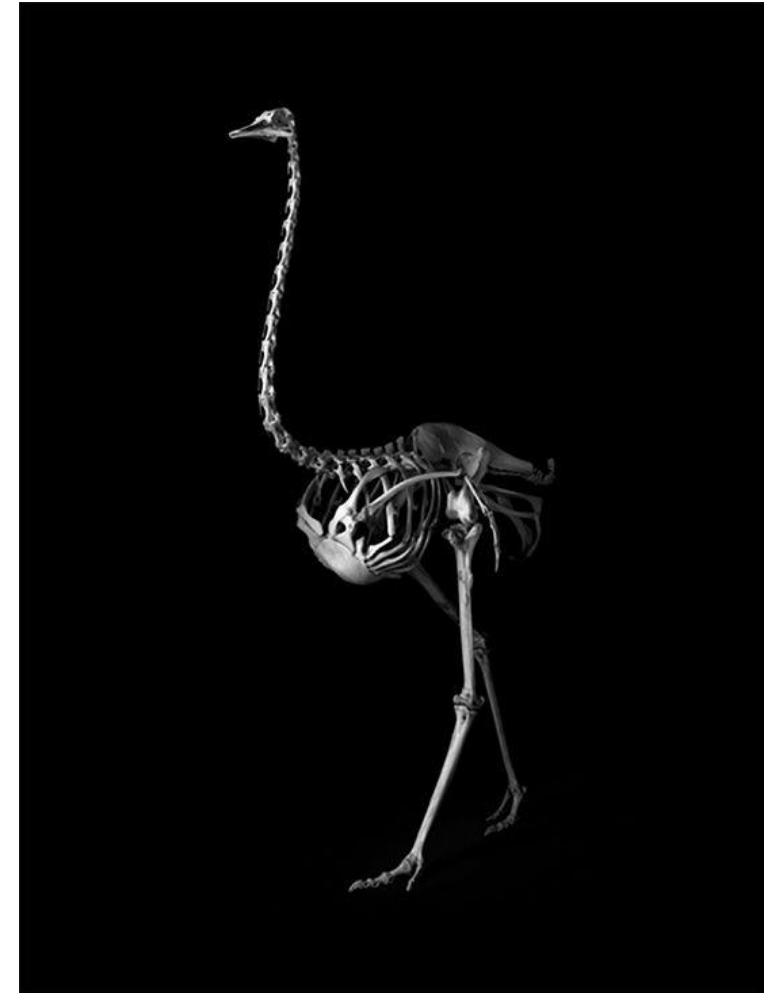


STERNUM

- 'flat' in flightless birds (like ostriches & rheas) but a large keel or **carina** (site of attachment of the large flight muscles) is present in most birds
- 1. rostrum, 2. craniolateral process, 3. thoracic process (=trabecula lateralis), 4. abdominal process (=trabecula intermedia), 5. trabecula mediana (**chicken**)



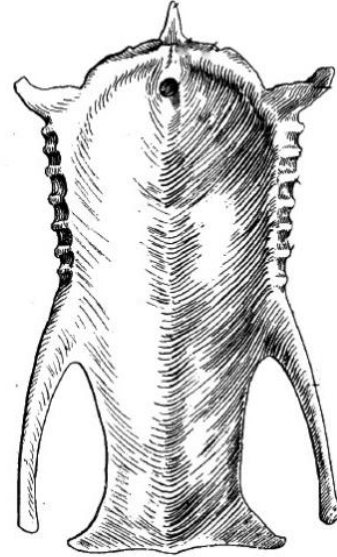
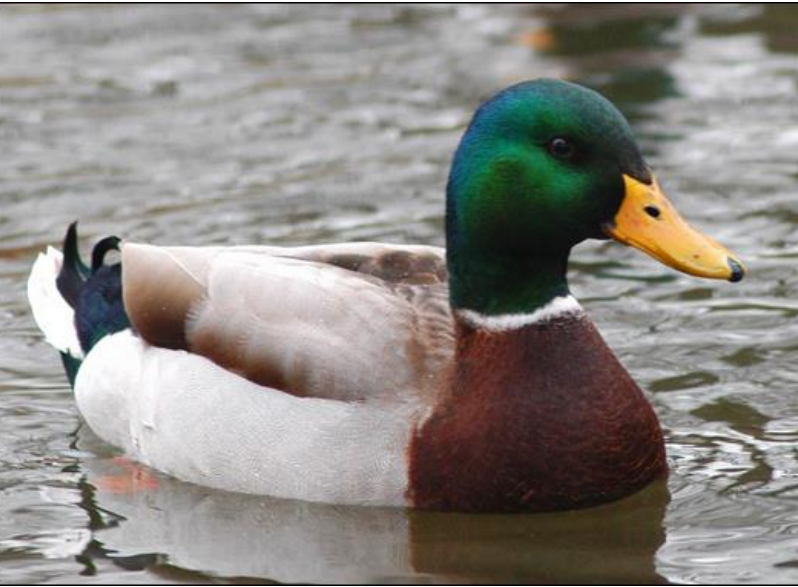
Sword-billed Hummingbird (*Ensifera ensifera*) skeleton



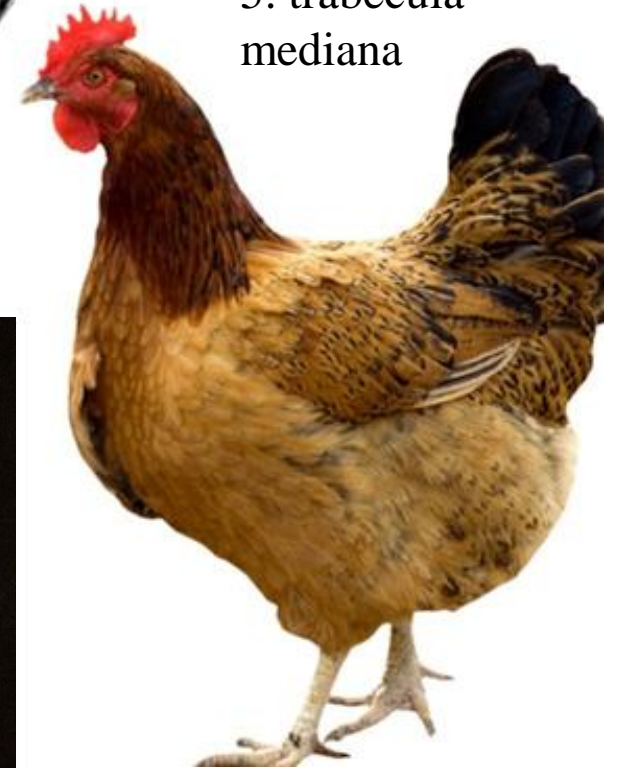
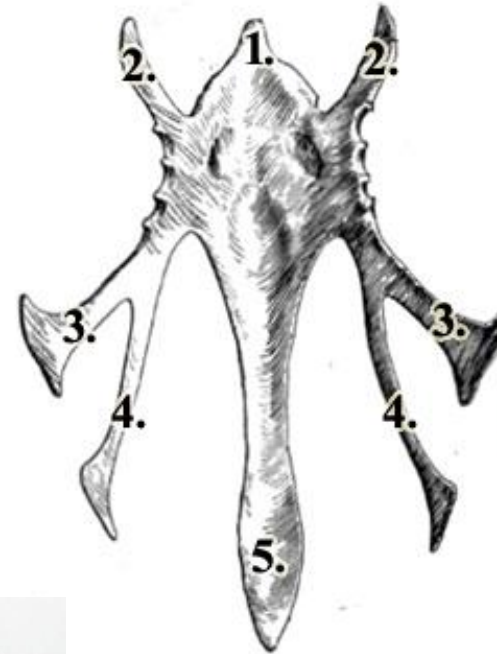
Ostrich skeleton

STERNUM

1. rostrum,
2. craniolateral process
3. thoracic process (=trabecula lateralis)
4. abdominal process (=trabecula intermedia)
5. trabecula mediana



Lateral trabecula is missing
(**duck**)



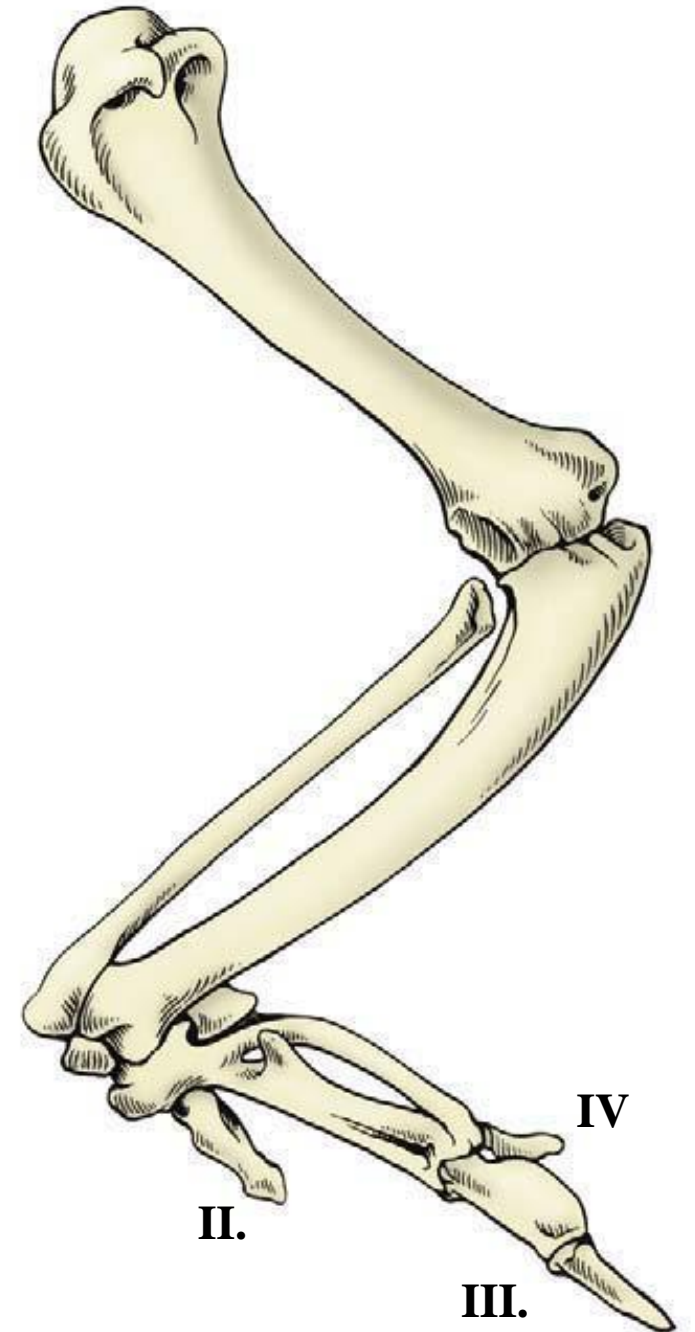
(**chicken**)

Intermedial and medial trabecula
forms a hole (fenestra medialis)
(**pigeon**)



FORLIMB

- Forelimb modified as wing
 - ulna is enlarged
 - carpal bones are reduced in number (just 2)
 - metacarpals – I & V metacarpals are lost;
- II, III, & IV are united (with vestigial carpals) to form the **carpometacarpus**
- **digits - only 3**, digitus alularis (II), digitus major (III), digitus minor (IV)
 - phalanges - few in number

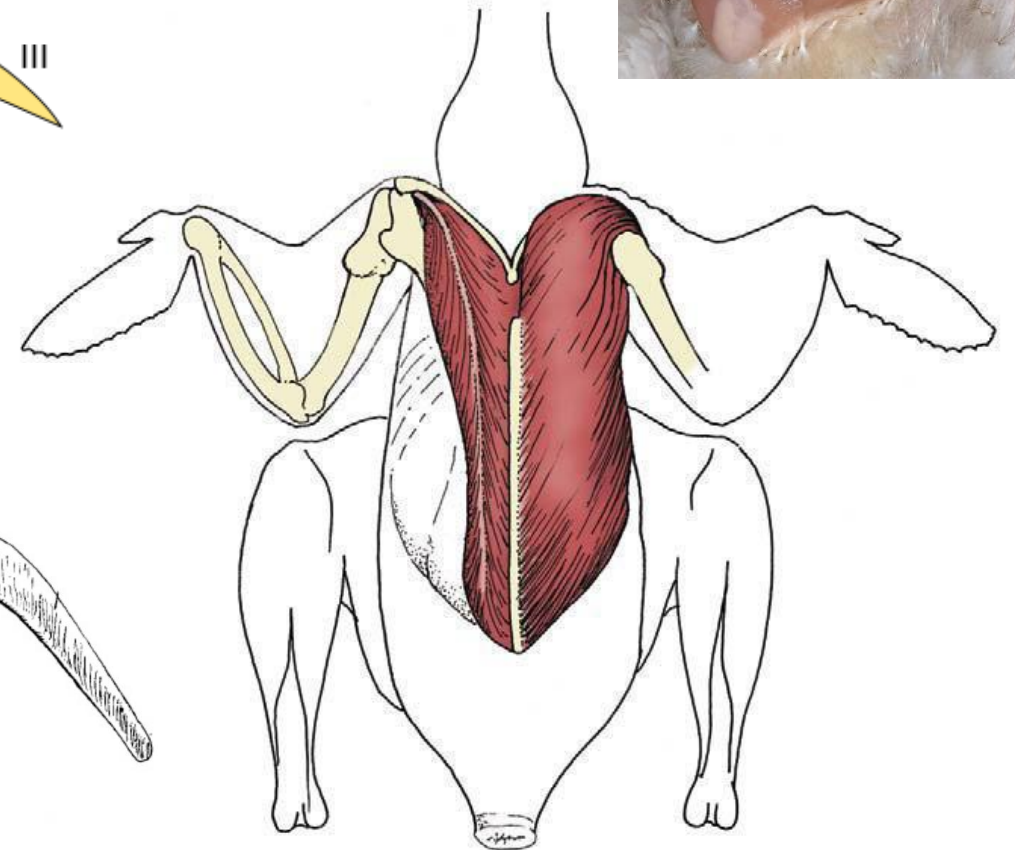
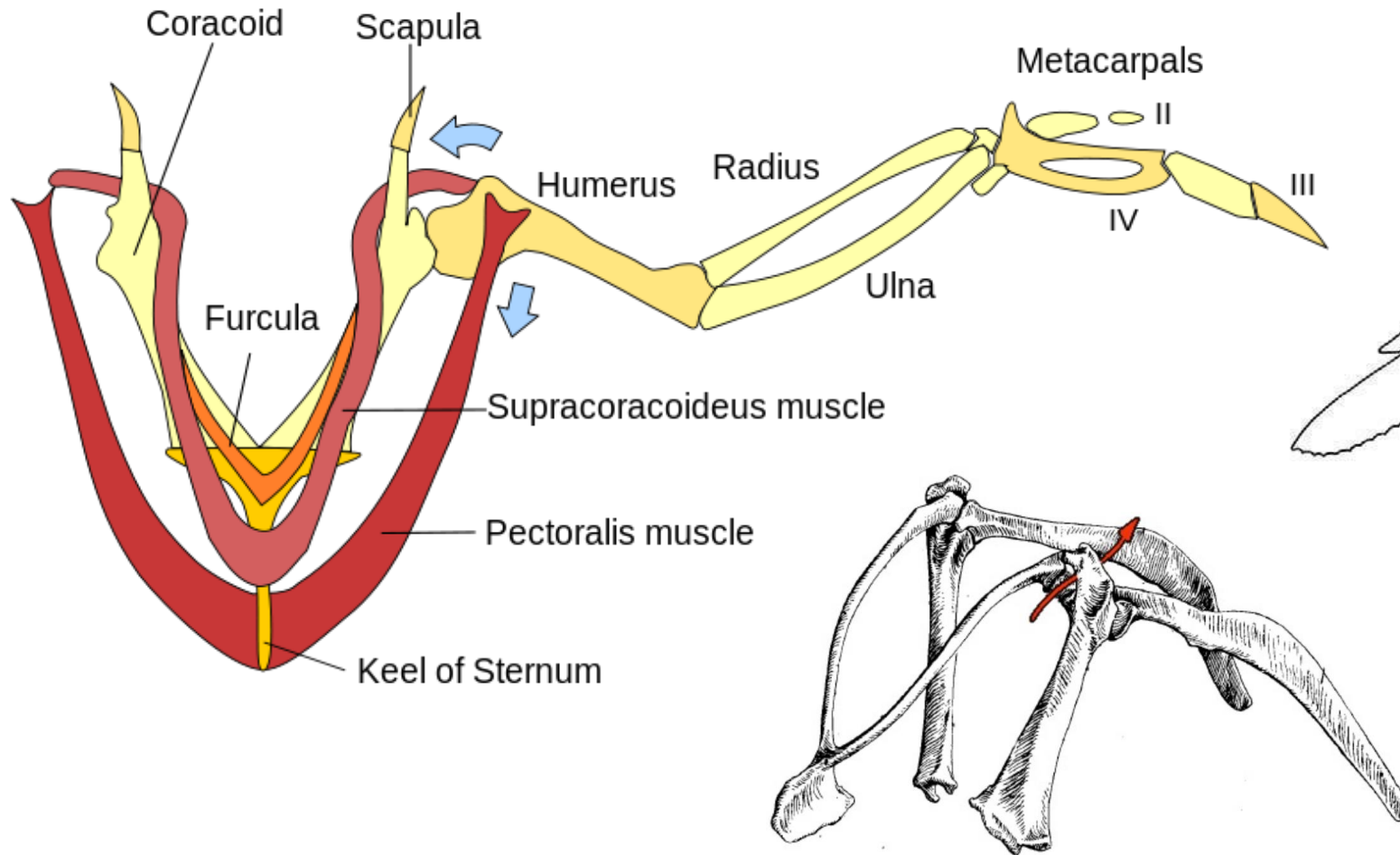


MUSCLES

Flight muscles are very large & located near the center of gravity:

- **m. pectoralis** downstroke muscle
- **m. supracoracoideus** upstroke muscle (going through: canalis triosseus)

Pigeons have 20% of their body weight made up by breast muscle

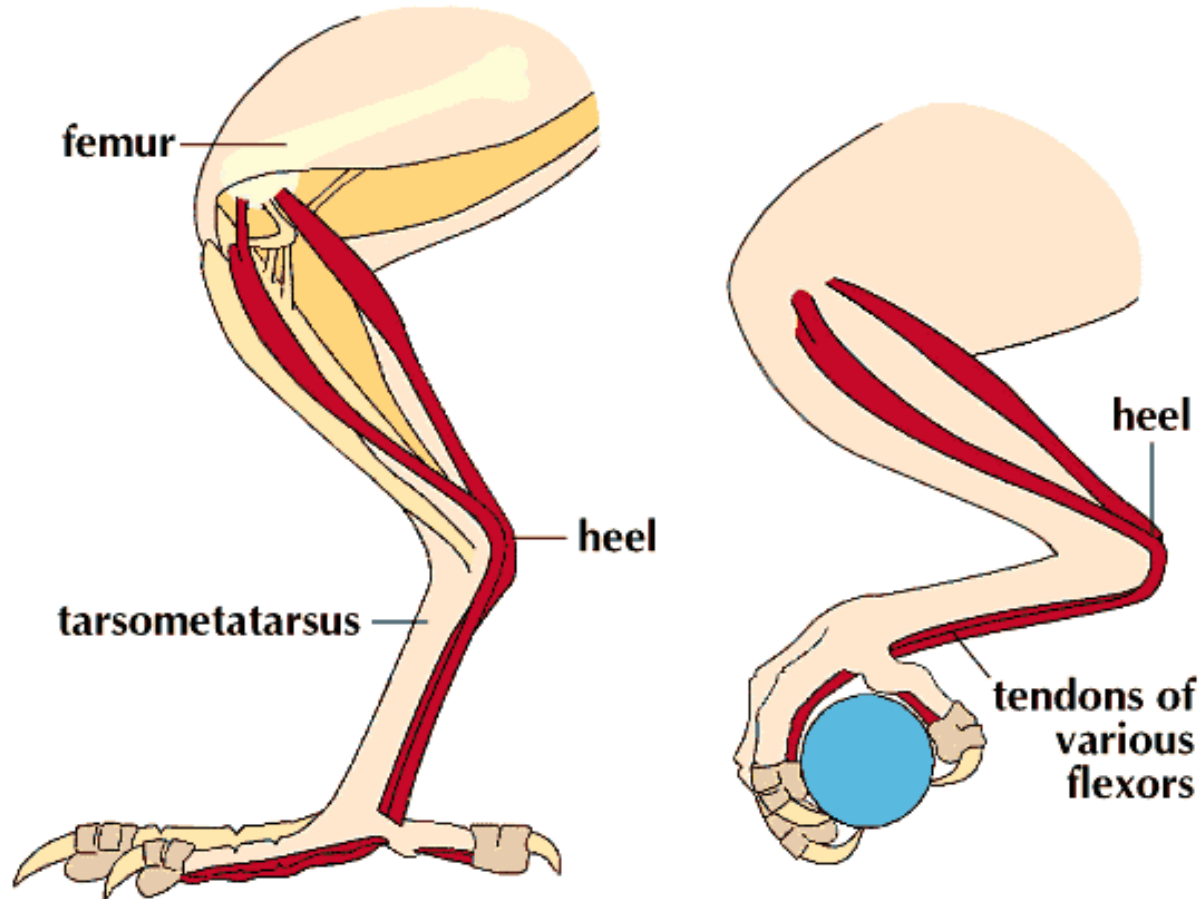


MUSCLES

Hindlimb muscles reduced in many species because:

- the rigid skeleton of birds (hindlimb, pelvic girdle, & synsacrum) provides much support, as a result, less musculature is needed
- hindlimbs are sometimes used for little else but perching (e.g., hummingbirds & swifts)

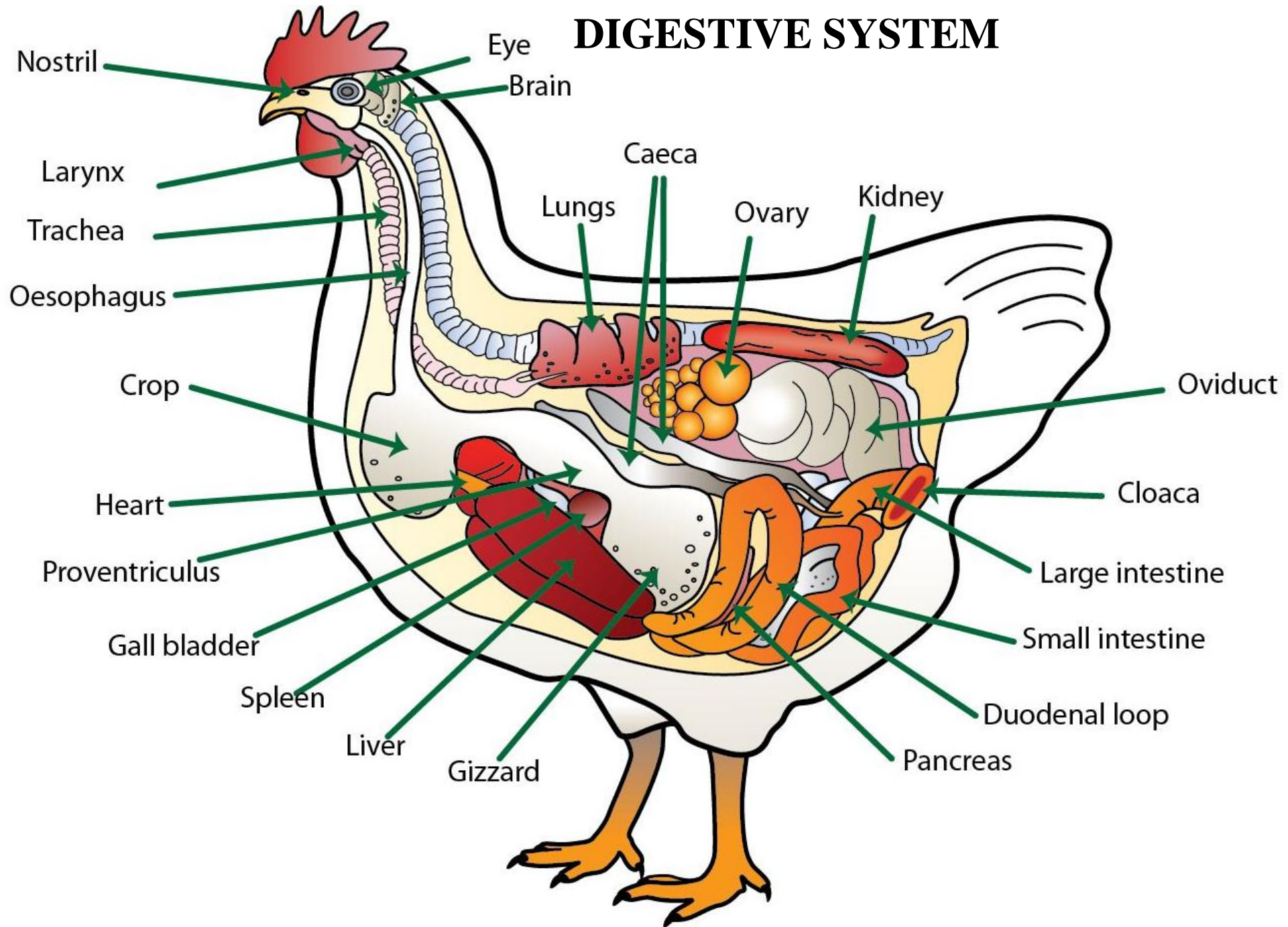
Perching Mechanism of a Bird



m. ambiens

- special mechanism
- the weight of the bird tightens the tendons
- if the stifle is flexed, the tarsus and the digits are also flexed
- no muscular energy needed
- bird will not fall off while sleeping

DIGESTIVE SYSTEM



DIGESTIVE SYSTEM

Crop (ingluvies)

- stores food (so food is continuously available)
- moistens, softens food
- in some species (pigeon, penguin) it produces crop-milk

Glandular stomach (proventriculus)

- secretes protein-digestive enzymes and acids

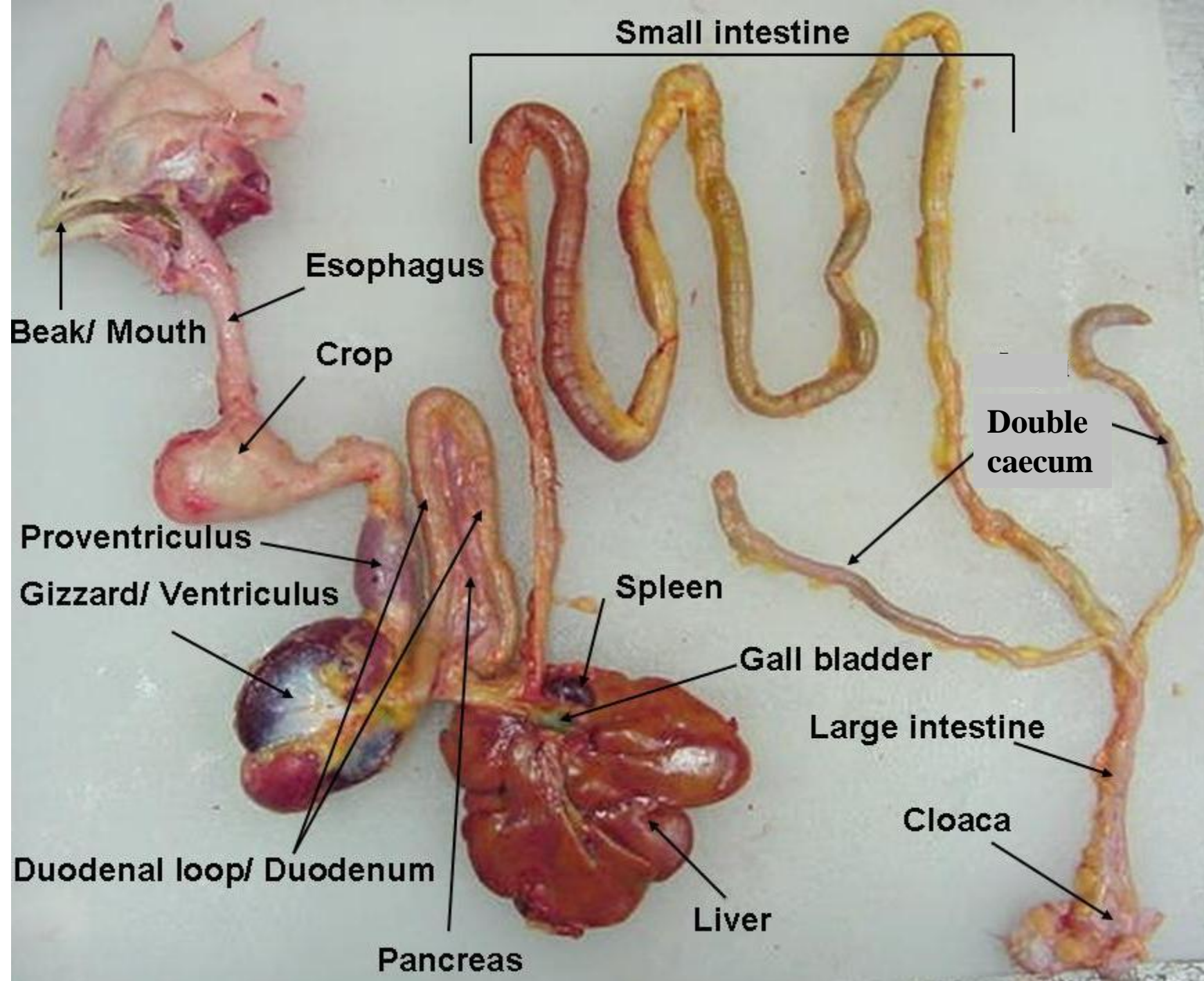
Muscular stomach/gizzard (ventriculus)

- mechanical digestion
- crushes and grinds the food
- contains small stones to act like teeth to grind the food up

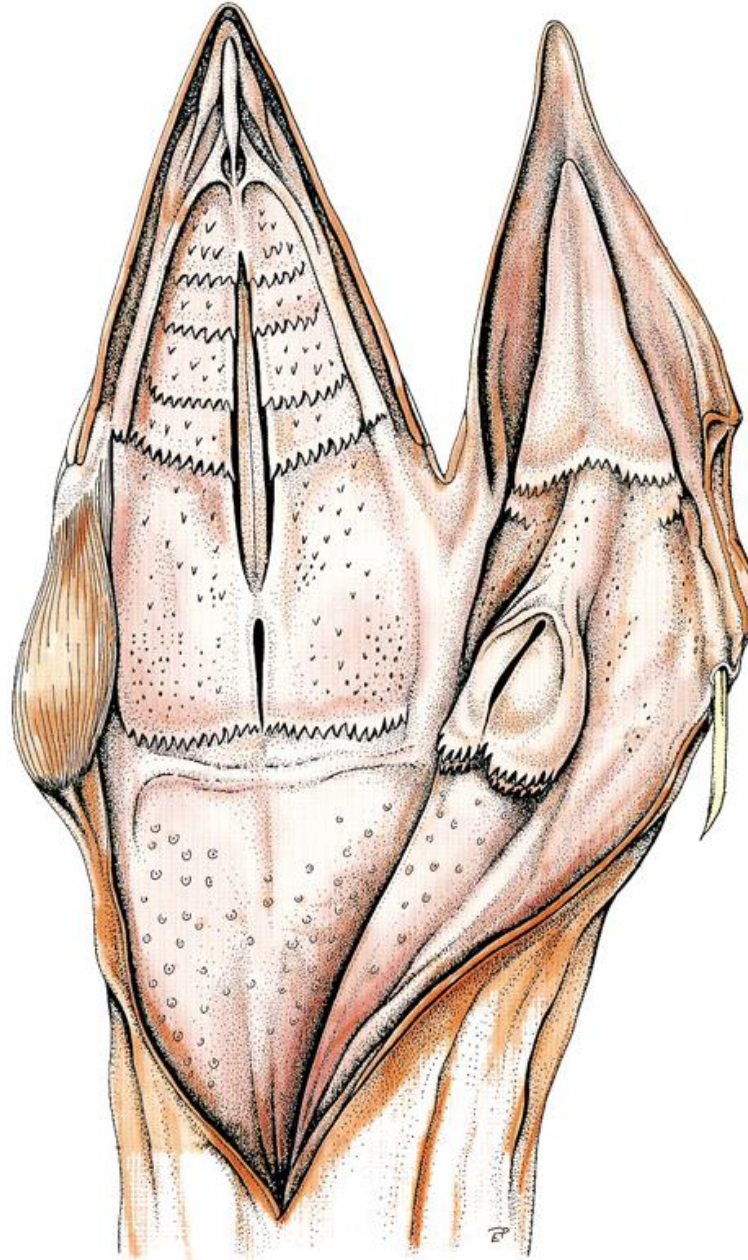
Small intestines, Large intestines

Cloaca

- Combination of the digestive, urinary and reproductive systems



OROPHARYNGEAL CAVITY



Beak

- no lips, no teeth, no chewing

Oropharyngeal cavity

No soft palate

Tongue non-protudable.

- papillae linguales
- papillae pharyngeales
- **aditus laryngis** (no epiglottis)
- papillae palatinae
- papillae pharyngeales
- **choana**
- **infundibulum**

TONGUE



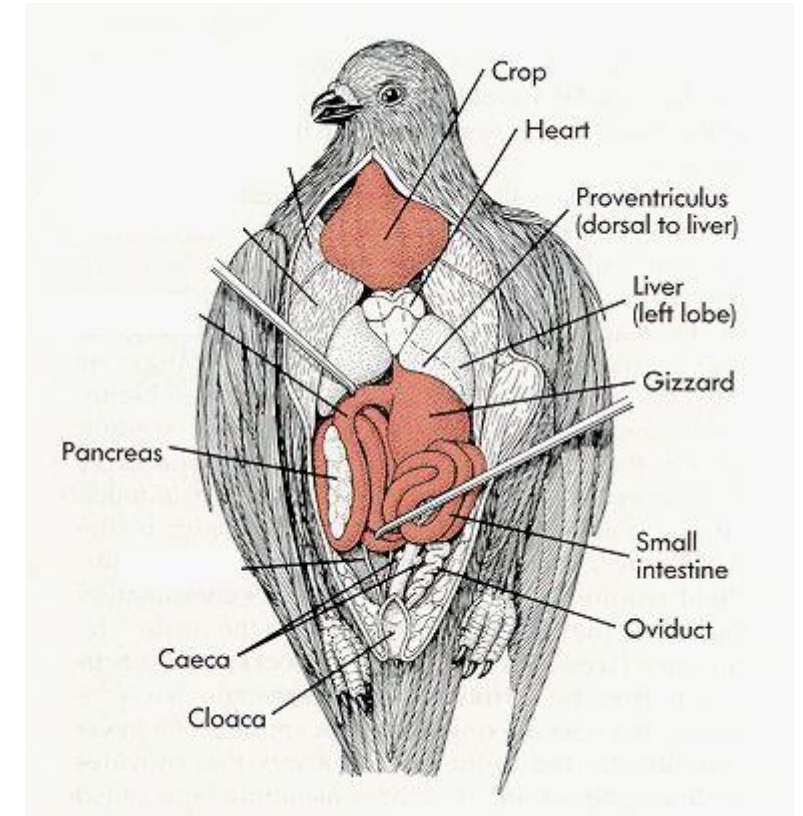
- Tongue non-protudable
- Without intrinsic muscles.



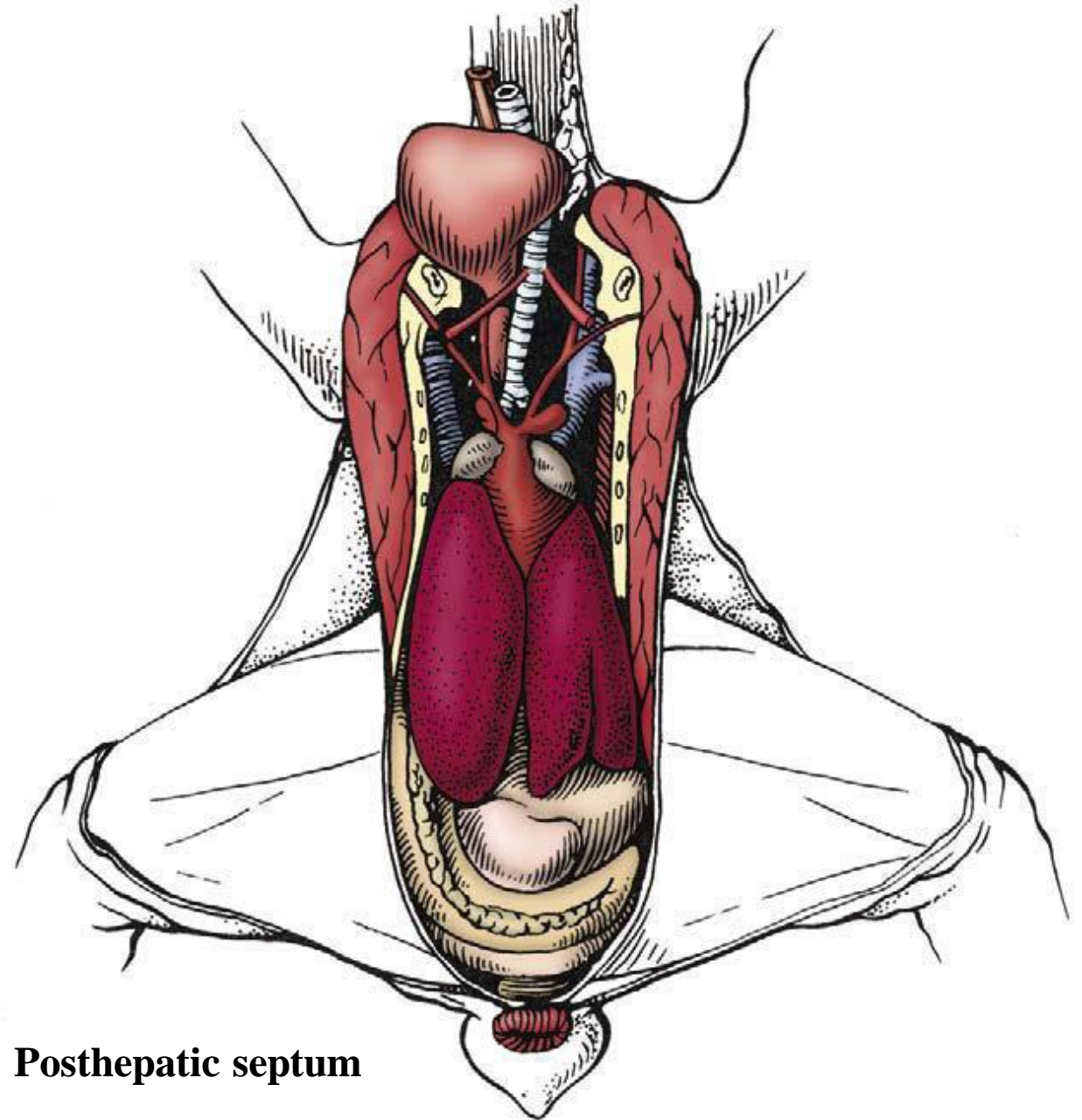
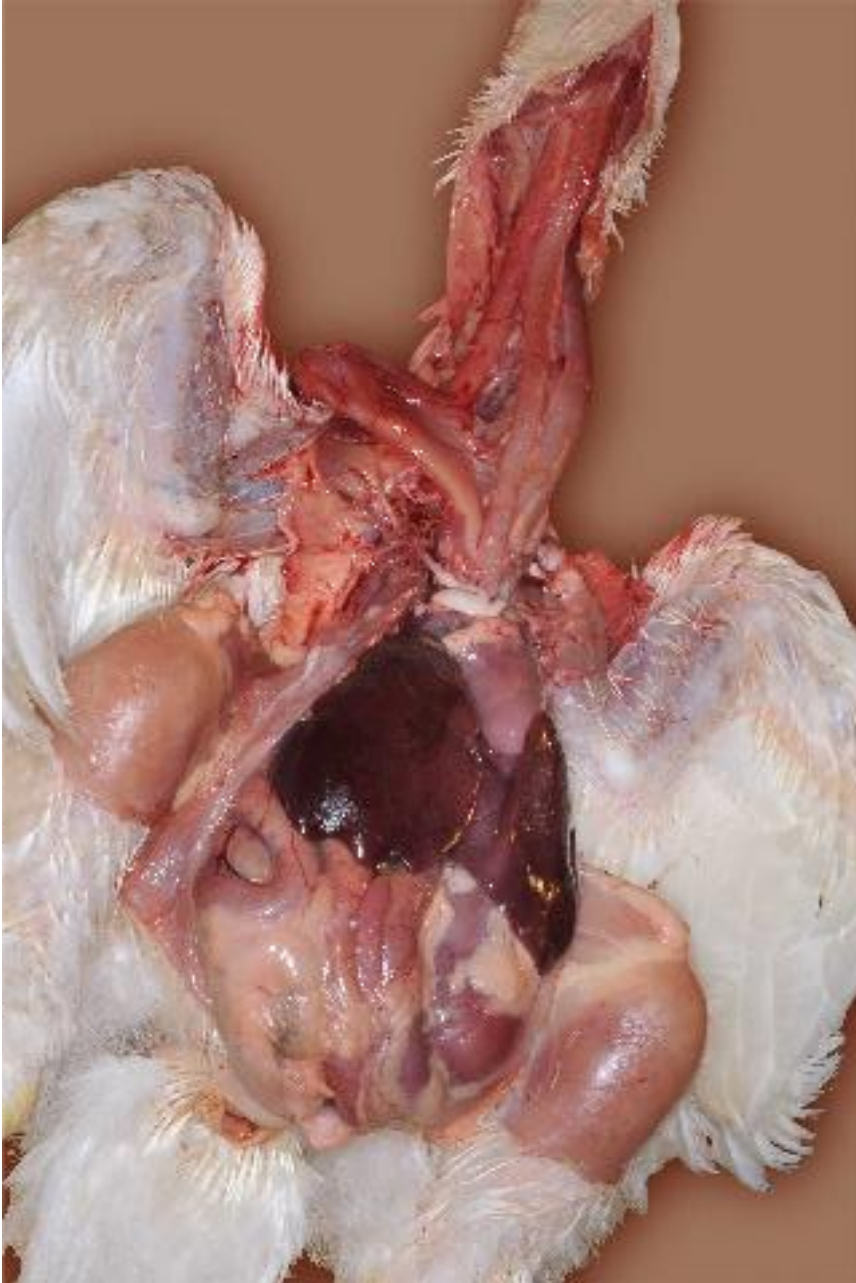
- Tongue protudable
- With intrinsic muscles.

CROP

- Large and muscular in **seed eating birds** (chicken, turkey)
- Small or missing in **ducks** and **geese**.
- **Pigeons** have epithelial cells in their crop sensitive to prolactin which slough when chicks (squabs) hatch, producing crop milk. Has 2 lateral sacs.
- **Owls** have no crops, so produce a pellet of indigestible material after every meal
- Most raptors, including hawks, eagles and vultures have a crop.



THORACOABDOMINAL CAVITY



Posthepatic septum

STOMACH

Glandular stomach (ventriculus glandularis)

isthmus ventriculi

Muscular stomach (ventriculus muscularis)

- m. crassus cranioventralis
- saccus cranialis
- m. crassus caudodorsalis
- saccus caudalis
- centrum tendineum
- **cuticula**

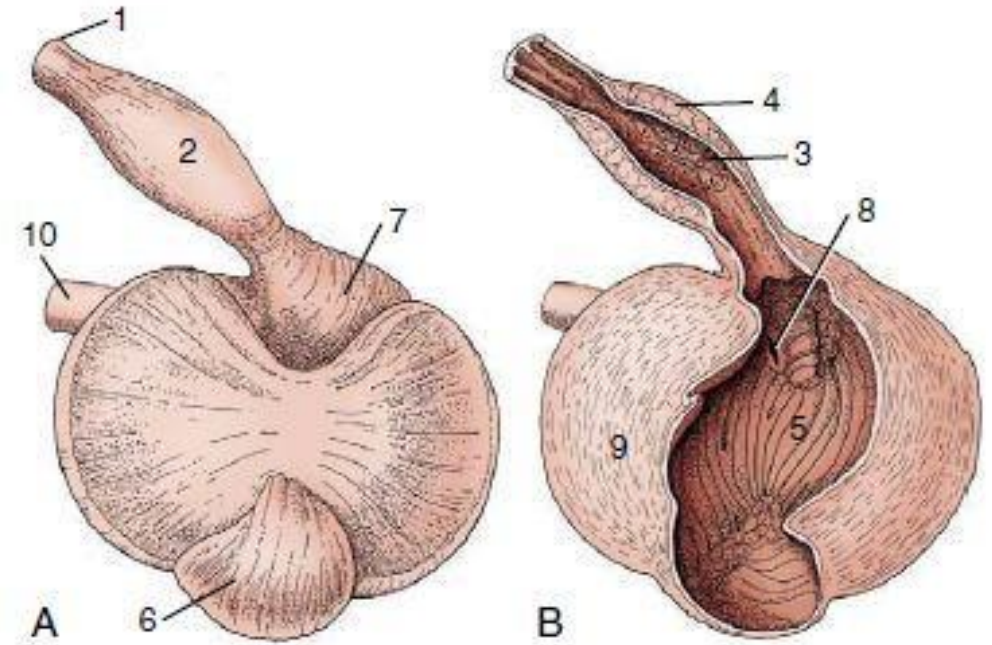
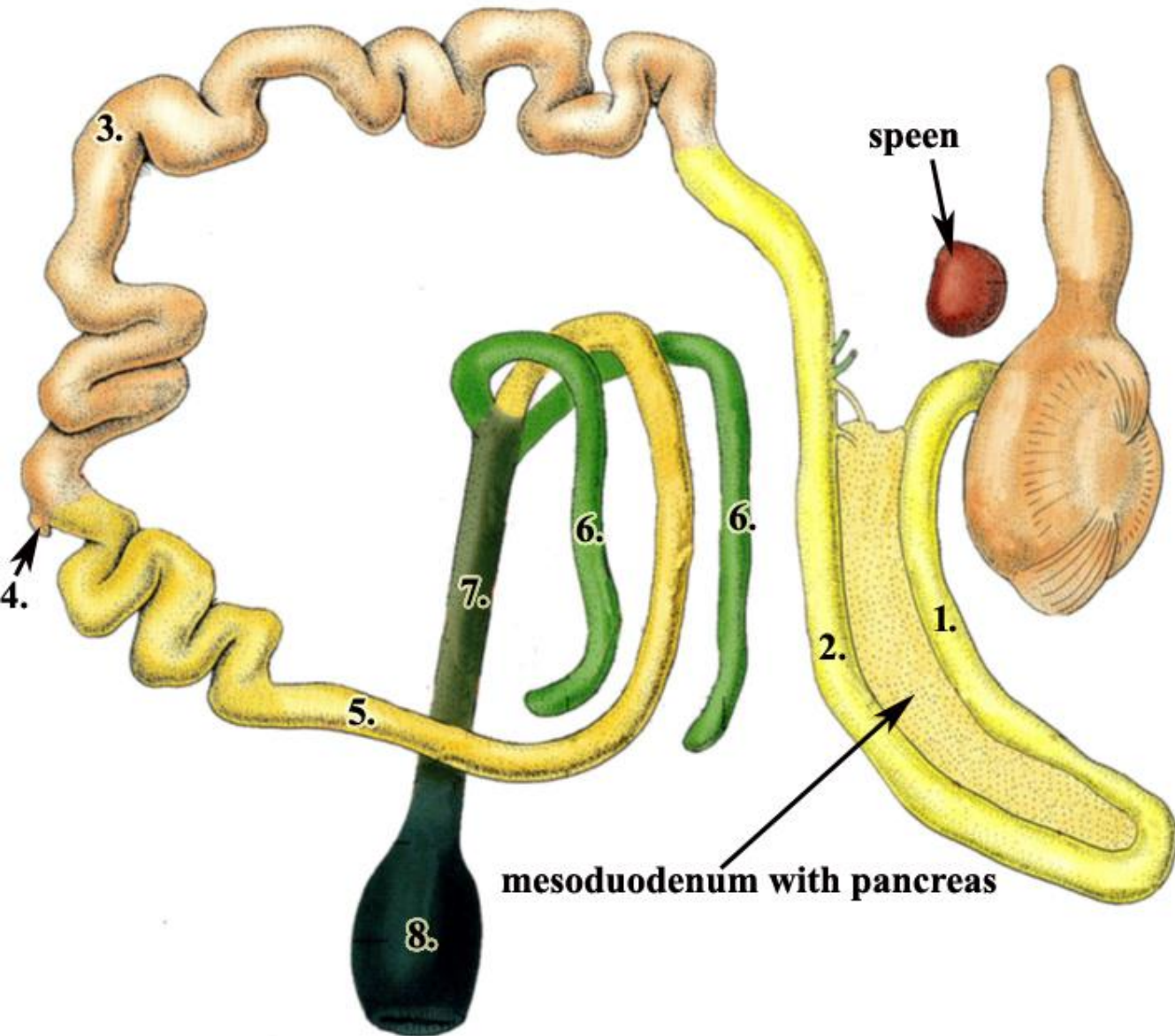


Figure 37-17 Stomach, ventral surface (A) and opened ventrally (B). 1, Esophagus; 2, proventriculus; 3, papillae; 4, deep proventricular glands, visible on cut surface; 5, lumen of gizzard; 6, caudal blind sac; 7, cranial blind sac; 8, pyloric orifice; 9, cranioventral muscle mass; 10, duodenum.

INTESTINES

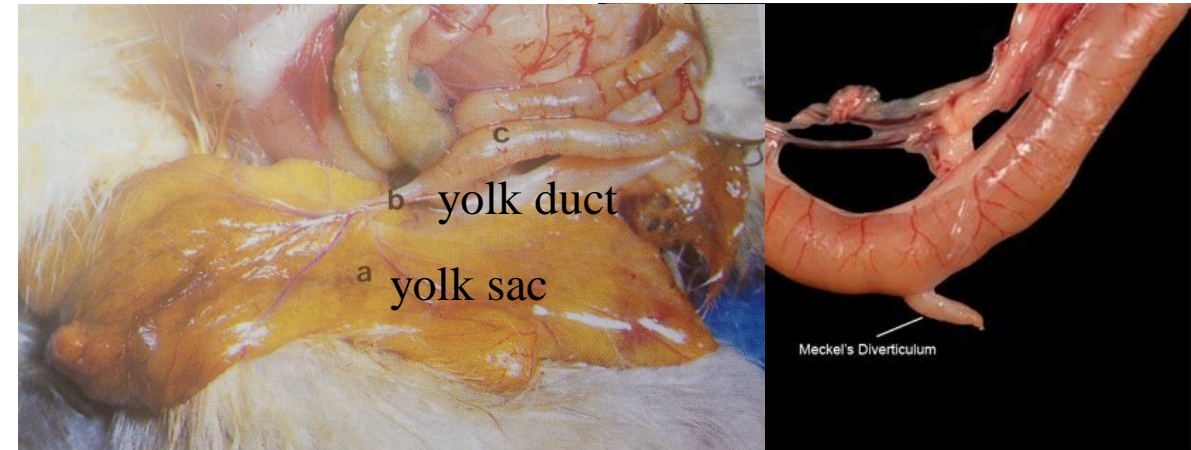


SMALL INTESTINE

- **Duodenum (1. duodenum descendens, 2. duodenum ascendens)**

pancreatic and bile ducts enter duodenum ascendens

- **3. jejunum**
- **4. Meckel's diverticulum** (yolk duct remnant)- at the border of the jejunum and ileum

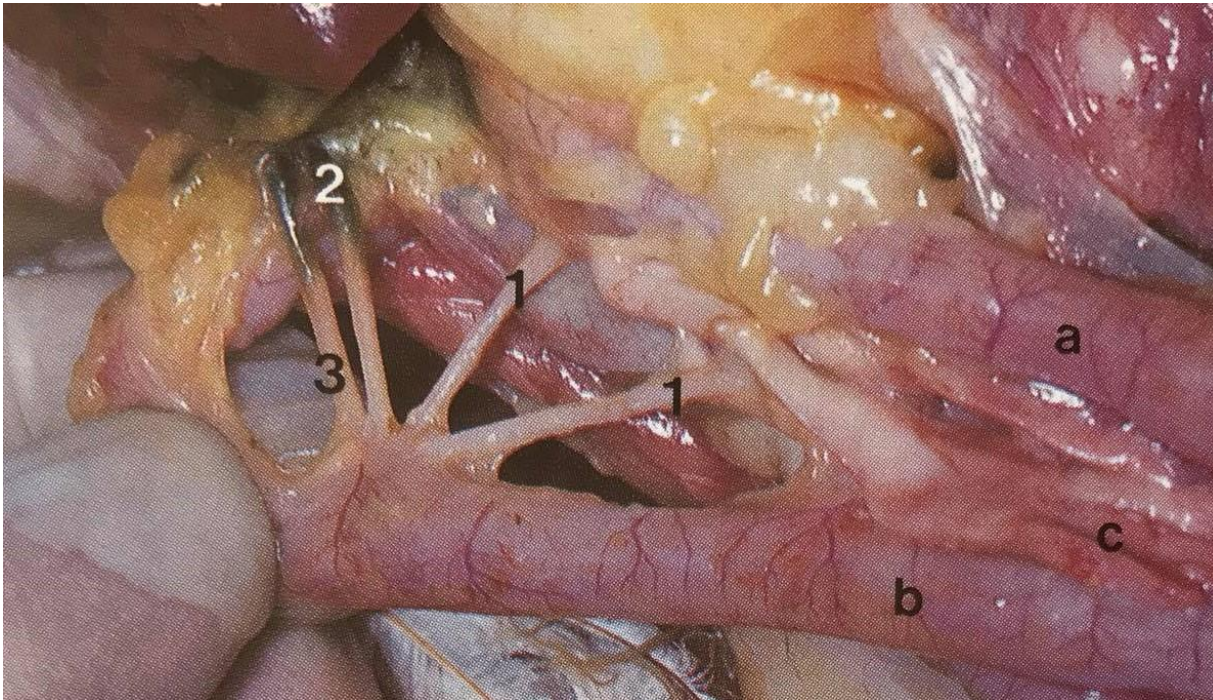


- **5. ileum**

LARGE INTENSTINE

- **6. double caecum-** small in carnivores, and big in herbivores
- **7. colorectum**
- **8. cloaca, ventum**

LIVER, PANCREAS, SPLEEN



Liver

- Chicken, turkey: the left lobe is divided into medial, lateral sub-lobes, the right is uniform
- The two ducts of the gall bladder open into the duodenum ascendens.
- Gall bladder missing: pigeon, ostrich.

Pancreas

The pancreas is located between the duodenum descendens and ascendens, with 2 lobes.

Spleen

Cherry-sized, reddish, rounded, placed on the right side next to the glandular stomach, and thoracic, abdominal air sacs.

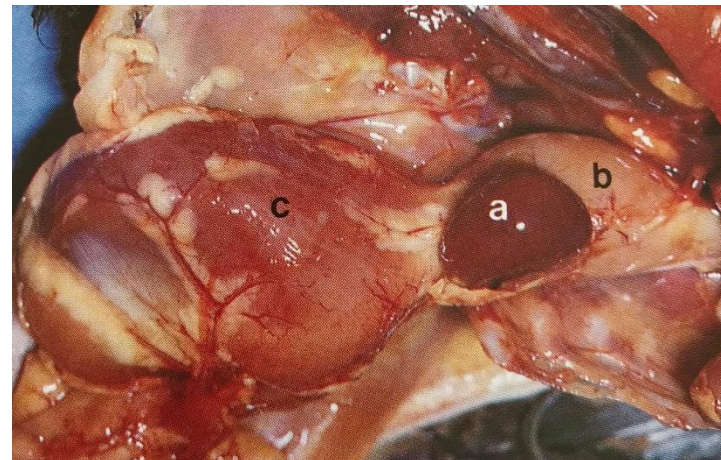
a duodenum descendens

b duodenum ascendens

c pancreas

1 ductus pancreaticus

2, 3 bile duct

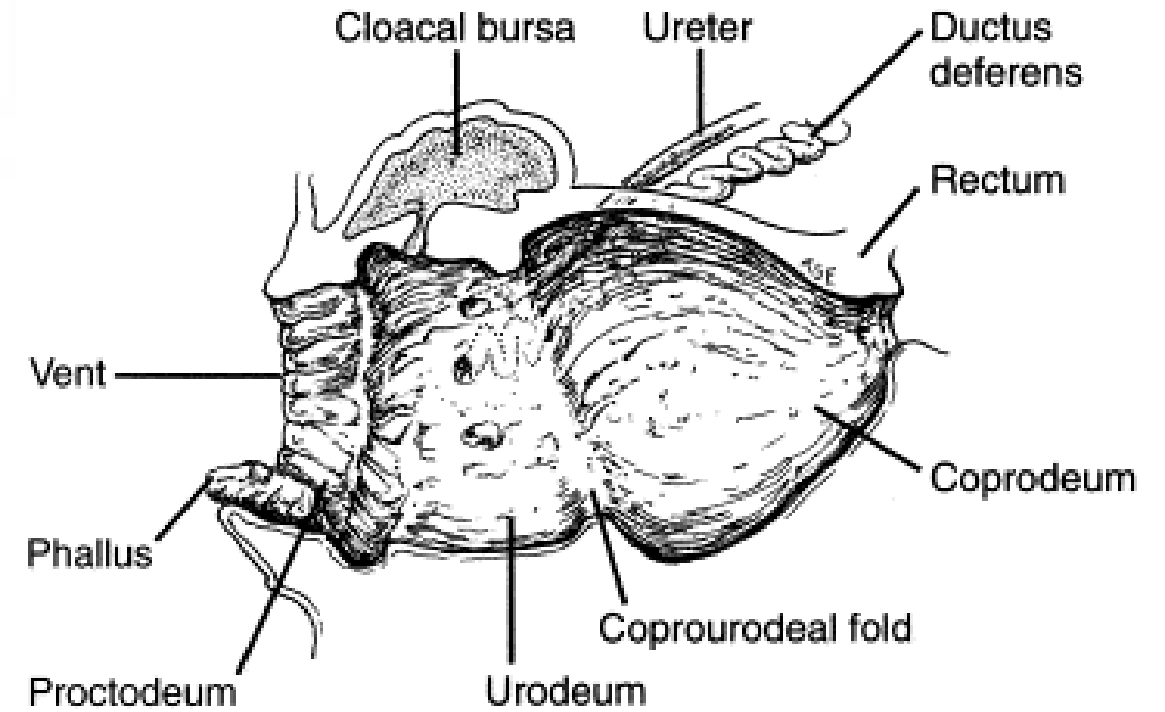
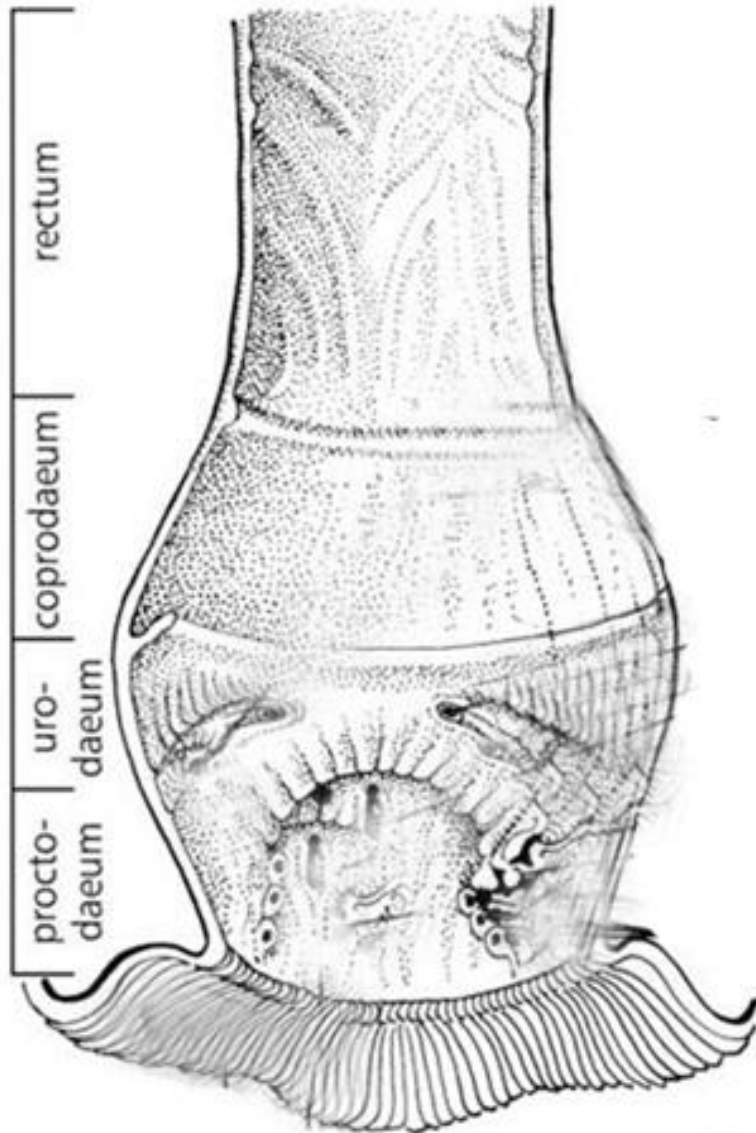


a lien

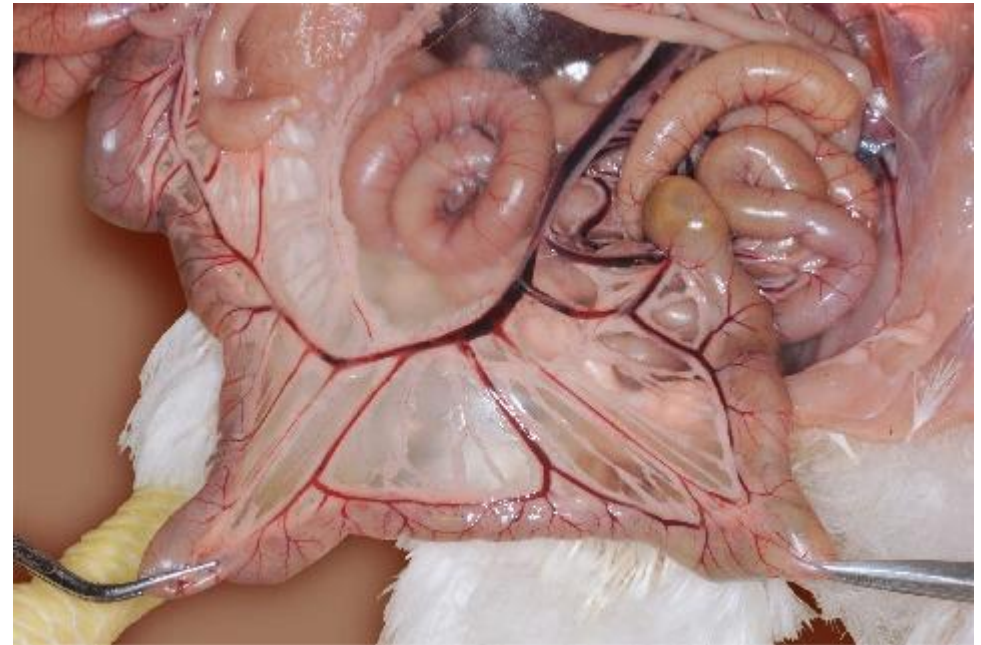
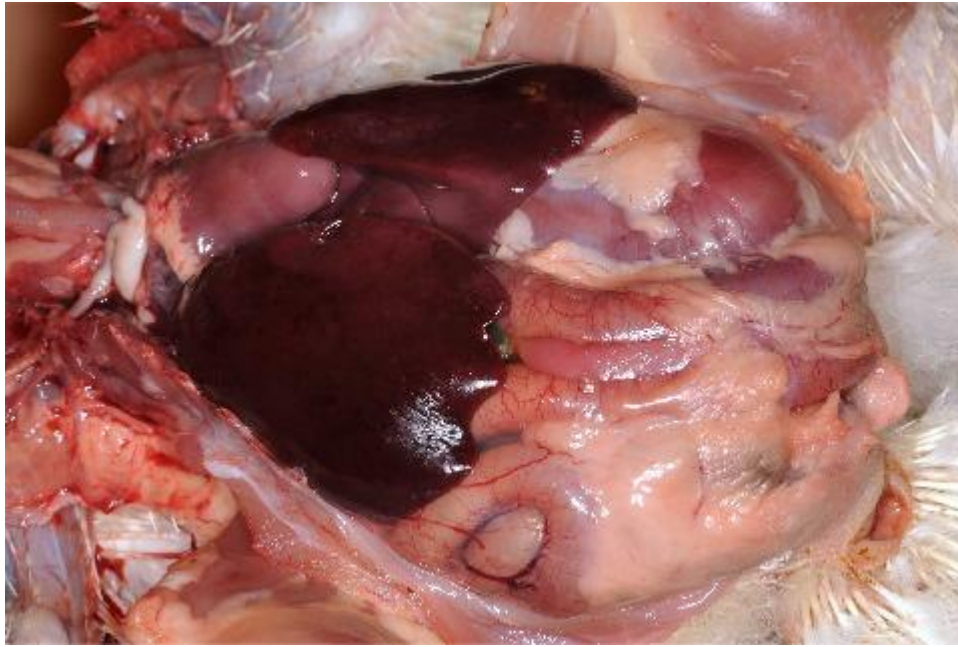
b ventriculus glandularis

c ventriculus muscularis

CLOACA



INTESTINUM TENUE



INTESTINUM CRASSUM

