PRACTICAL GUIDE TO OSTEOLOGY AND SYNDESMOLOGY OF DOMESTIC ANIMALS

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DEDICATION

To all Veterinary Medical Students and Veterinary Anatomists

"Even slaves are free if their visions are greater than their chains. Never give up"

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PREFACE

Veterinary Gross anatomy is a basic medical science subject that introduces a medical student to so many new vocabularies and terms forming the back bone on which subjects such as physiology, pathology, theriogenology, surgery, and radiology are built. Hence the need for every undergraduate veterinary students to comprehend gross anatomy. The fact that students' culture of reading textbooks has diminished makes this compendium of utmost importance as it illustrates anatomical structures associated with bones and joints while ensuring its assimilation through practical instructions.

The Unique aspect of this compendium is that it serves as a reference text and practical workbook for comparative anatomy of the skeletal system in domestic animal species. Indeed the authors need to be commended for the dedication and hard work that achieved this compendium. It is therefore hopeful that it will be helpful for Veterinary students to improve their understanding of Veterinary Gross Anatomy.

Salami, S. O.

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SECTION A: **OSTEOLOGY**

Chapter 1: Skeleton

Chapter 2: Skull

Chapter 3: Vertebral column

Chapter 4: Thorax

Chapter 5: Fore limb

Chapter 6: Hind limb

Chapter 1: **SKELETON**

The term “skeleton” applies to the framework of hard structures which support and protect soft tissues of animals. In the descriptive anatomy of the higher animals it is usually restricted to the bones and cartilages, although the ligaments which bind these together might well be included.

The skeleton may be divided primarily into three parts: (1) axial (2) appendicular (3) splanchnic.
The axial skeleton comprises the Skull, vertebral column, ribs and sternum.
The appendicular skeleton includes the bones of the fore and hind limbs.
The splanchnic skeleton consists of certain bones developed in the substance of some viscera or soft organs. For example; the os penis of the dog and the os cordis of the ox.

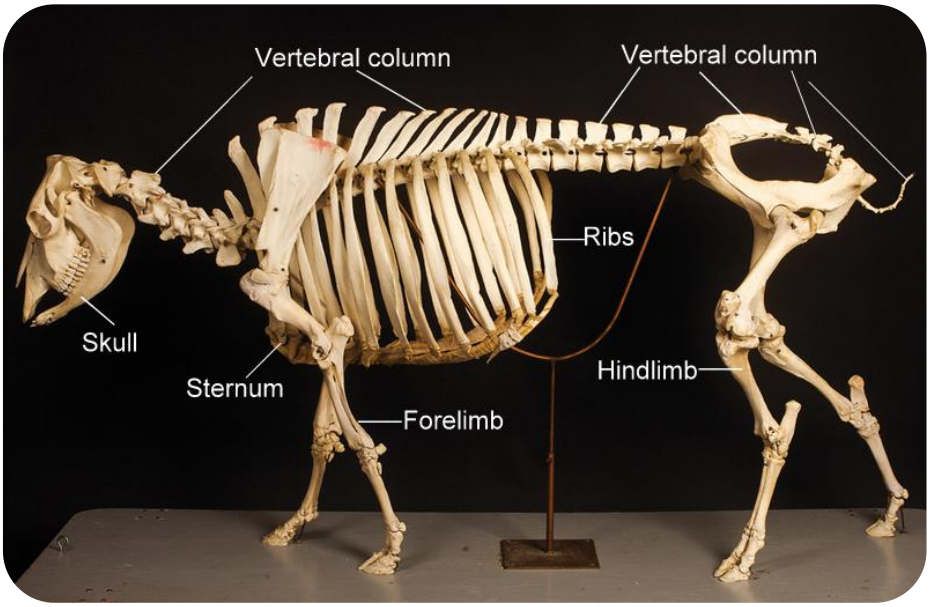


Figure 1.0: Bovine mounted skeleton showing parts of the skeleton

BONES

Bones are rigid organs that constitute part of the endoskeleton of vertebrates. They are living structures which have blood vessels, lymphatic vessels, and nerves; are subject to disease; can undergo repair; and adjust to changes in stress.

CLASSIFICATION OF BONES

On the basis of shape, bones of the body are usually classified into five sub-classes.

1. Long bones
These are cylinder-like structures greater in one dimension than the other. They function chiefly as levers and aid in support, locomotion and prehension.
Examples: Bones of the limbs.

2. Short bones
These are somewhat cuboidal or approximately equal sides in appearance.
These function chiefly in absorbing concussion, and are found in complex joints such as knee or hock where a variety of movements as well as absorption of shock is required.
Examples: Carpal and tarsal bones.

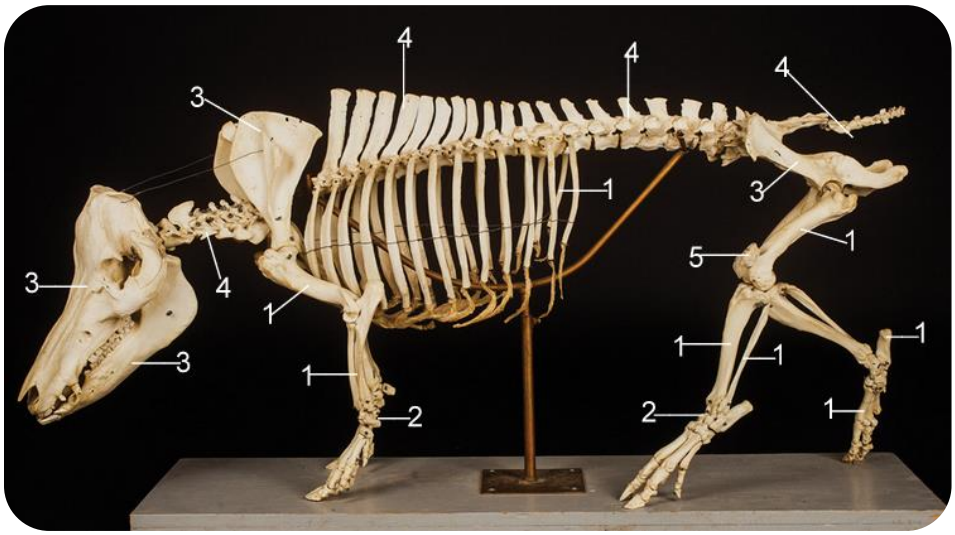


Figure 1.1: Porcine skeleton showing bone classification based on shape. 1, Long bones, 2, Short bones, 3, Flat bones, 4, Irregular bones, 5, Sessamoid

3. Flat bones
These are relatively thin, and expanded in two dimensions.
They function chiefly for protection of vital organs e.g. brain, heart, lungs, pelvic viscera but also provide large surface for muscle attachment.
Examples: Scapula, bones of the skull and ilium.

4. Irregular bones
These are unpaired bones located in the median plane of the body. They are important for protection, support and muscle attachment.
Examples: Bones of the vertebrae and sternebrae.

5. Sesamoid bones

These are small or tiny irregularly shaped bones that resemble sesame seeds and are developed along the course of tendons to reduce friction or change the course of tendons.
Example: Navicular bone. N.B: The patella (knee cap) is the largest sesamoid bone in the body.

FUNCTIONS OF BONES

1. It makes the foundation and proper shape of the body.
2. It supports and furnishes attachment to soft organs of the body e.g. muscles and vicera etc.
3. It protects certain soft and delicate tissues of the body e.g. brain enclosed in the cranial cavity, heart enclosed in the rib cage.
4. Bones act as levers in various articulations of the body and thus indirectly help in locomotion.
5. Bones of pneumatic type present in the fowl help in flying by reducing weight of the body.
6. It helps in erythropoiesis e.g. red and white blood cell formation.
7. It helps in hearing e.g. ossicles in ear.
8. It acts as storehouse of calcium and phosphorus.
9. They help in respiration e.g. ribs.
10. They help in deglutition e.g. hyoid apparatus.

SURFACE CONTOUR OF BONE

The surfaces of bones present a great variety of eminences, depressions/cavities and perforations which play specific roles in life.
There is a functional, embryological and pathological reason for the existence of every feature. The prominences and cavities may be articular or non-articular, serving for the attachment of muscles, fascia, ligaments, and tendons.

ANATOMICAL DESCRIPTIVE TERMS

In order to indicate precisely the position and direction of parts of the body, certain descriptive terms are employed, and must be understood. In the explanation of these terms it is assumed here that they apply to a quadruped such as the horse in the ordinary standing position.

Dorsal/Superior: …… relatively nearer to the top of head, body, back of neck, trunk or tail.
Ventral/Inferior: …… towards or relatively nearer to the underside of the head or body.
Medial: …….. toward or relatively nearer to the median plane.
Lateral: …….. relatively away from the median plane.
Cranial/Anterior: …….. toward or relatively nearer to the head.

Caudal/Posterior: …….. toward or relatively nearer to the tail.
Rostral: …….. relatively nearer to the nose; applies to the head only.
Oral: …….. towards the oral cavity.
Aboral: …….. away from the oral cavity.
Internal/Inner: ……close to, or in the direction of, the cavity of a hollow organ.
External/Outer: ……. away from the center of a hollow organ.
Superficial: …… relatively nearer to the surface of a body, or a solid organ.
Deep: …….. relatively nearer to the center of a body or solid organ.
Proximal: …….. relatively nearer to the main mass of the body or trunk.
Distal: …… away from the main mass of the body or trunk.
Volar and Palmer: …….denote caudal aspect of the forepaw below the carpal bones on which the pads are located.
Plantar: …….. denotes caudal aspect of the hindpaw below the tarsal bones on which the pads are located.
Axis: …….. the central line of a body or any of its parts.
Axial: …… relatively nearer to the longitudinal axis.
Abaxial: …….. away from the longitudinal axis of a body or part.

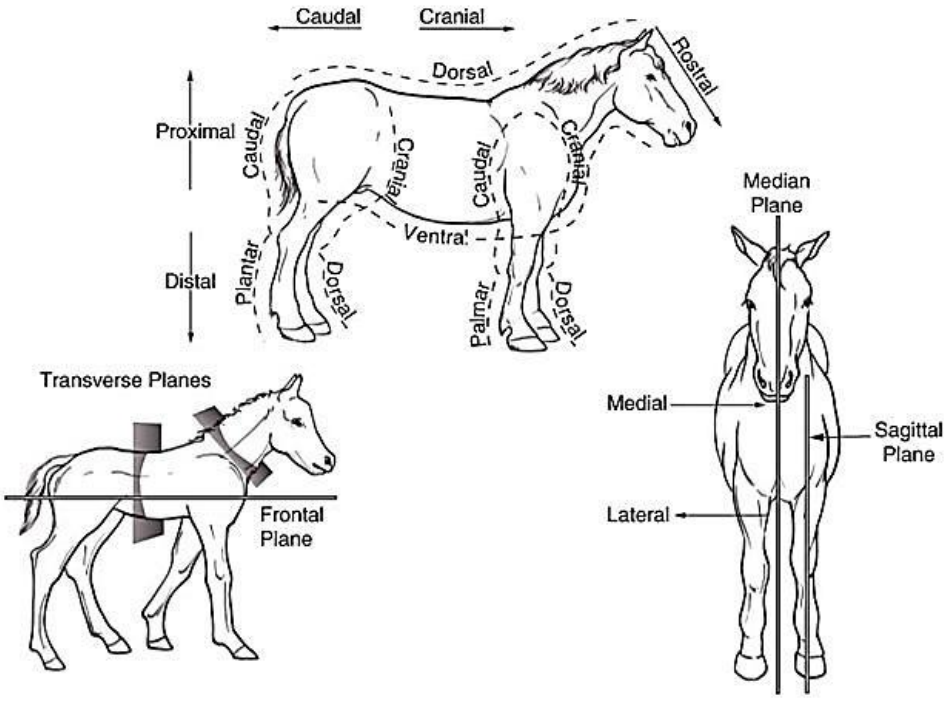


Figure 1.2: Some descriptive terms of the Horse

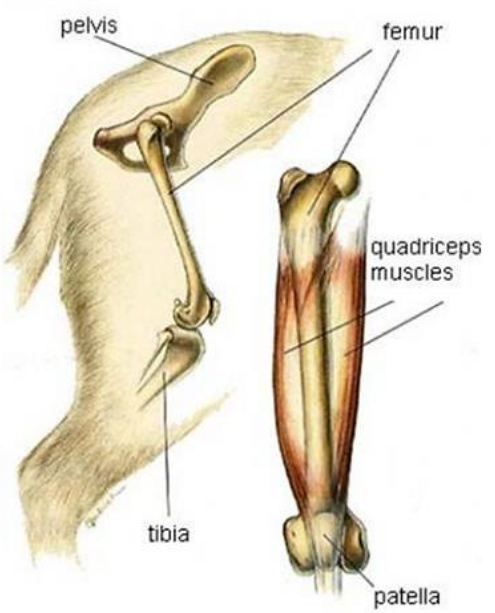
Plane: ……..A surface (real or imaginary) along which any two points can be connected by a straight line.
Median plane: ……It refers to the plane, which divides the body, including the head and tail, into right and left, two symmetrical halves. The term has also been applied to a plane dividing a limb longitudinally into halves.
Sagittal plane: ……..A plane parallel to the median plane.
Transverse/Segmental plane: ……..It refers to a plane perpendicular to the long axis of the body or part.
Dorsal/Oblique/Frontal Plane: ……It runs at right angle to the median and transverse planes and thus divides the body into dorsal and ventral portions.

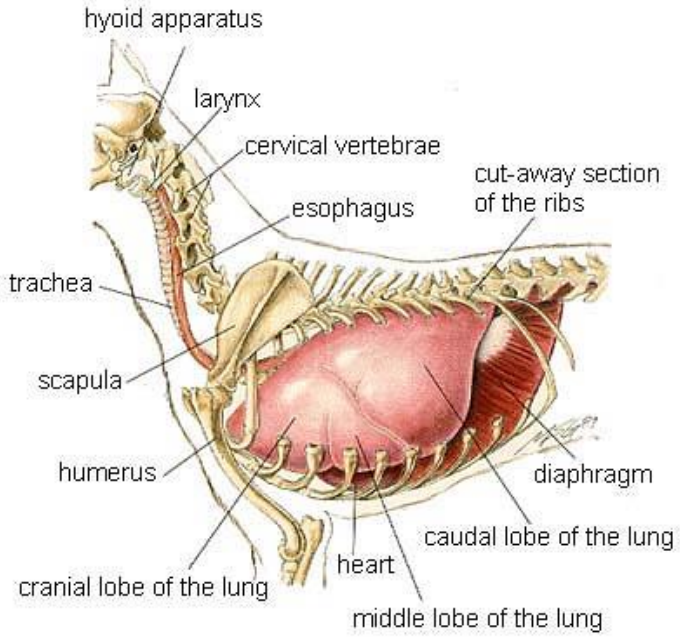
BONE FEATURES

Some general and specific bone features that will be encountered when studying bones are described below:

Tuberosity (Tuberositas): A large non-articular rounded projection.
Tubercle (Tuberculum): A smaller tuberosity.
Process (Processus): A vague term generally applied to a projection.
Trochanter: A term specialized for a tuberosity on the femur.
Spine (Spina): An elongated thin pointed line.
Crest (Crista): A linear sharp ridge.
Line (Linea): A very faint ridge.
Head (Caput): A rounded, smooth, strongly convex articular projecting process, situated at the end of the long bones.
Neck (Collum): A constricted attachment between head and shaft of the bone.
Condyle (Condylus): A smooth, convex, articular, large cylindrical, protruding mass situated at the end of the long bones.
Epicondyle: A rough enlarged area, which lies proximal to the condyles.
Facet: A small articular surface, which may be flat, concave or convex.
Glenoid Cavity (Cotyloid cavity): A smooth and deep articular depression.
Trochlea: A large pully-like articular mass.
Cochlea: An articular surface reciprocal to that of trochlea.
Sinus: An air cavity within a bone.
Foramen: A perforation in a bone.
Canal: A tunnel through one or more bones.
Fossa: A large non-articular depression.
Fovea: A small non-articular depression.

ACTIVITY: Answer the questions below





a) Describe the position of the Femur in relation to the
   Pelvis _____
   Patella _____
   Tibia _____
   Quadriceps muscles _____

b) Describe the position of the Scapula in relation to the
   Humerus _____
   Ribs _____
   Oesophagus _____

c) Describe the position of the vertebral column in relation to the
   Lungs _____
   Scapula _____
   Ribs _____

Chapter 2**: SKULL**

The skull of domestic animals is an elongated bony structure comprising all bones of the head which inclines slightly obliquely downward forming the cranial part of the animal. The head consists of the cranium and the face, hence it is convenient to divide the bones into cranial and facial groups.

The *cranial bones* enclose the brain with its membranes and vessels and the essential organs of hearing. They concur with the facial bones in forming the orbital and nasal cavities, in which the peripheral organs of sight and of smell are situated. They include the following: **Occipital, Parietal, Interparietal, Sphenoid, Ethmoid, Frontal and Temporal.**

The *facial bones* form the skeleton of the oral and nasal cavities and also support the larynx and the root of the tongue. They include the following: **Nasal, Premaxilla/incissive, Maxilla, Palatine, Pterygoid, Lacrimal, Malar/Zygomatic, Turbinates, Vomer, Mandible and hyoid.**

INSTRUCTION:

Identify the skull of any domestic animal in the bone collection and study the positions of the above mentioned bones as stated below. N.B: some bones may be absent in some species. This will be discussed later.

Occipital (Single) - Situated at the caudal part of the cranium of which it forms the caudal wall and part of the ventral wall or base. Its lower part is perforated centrally by a large, almost circular opening, the foramen magnum, at which the brain and spinal cord join.

Parietal (Paired) – Situated dorso-caudal; rostral to the Occipital or entirely dorsal to the Occipital.

Interparietal (Single) - Situated dorso-caudal, centrally placed between the Parietals or between the parietals and Occipital.

Sphenoid (Paired) - Situated ventro-caudal; it's central part is rostral to the occipital that continued ventrally

Ethmoid (Single) – Placed vertically between the cranial and nasal cavity (seen only when cranium is open). Situated internally in front of the body and orbital wings of the sphenoid. It projects forward between the orbital plates of the frontal bones and enters into the formation of the cranial, nasal, and paranasal cavities.

Frontal (Paired) – Situated dorso-caudal; rostral to the parietals

Temporal (Paired) – It forms the greater part of the lateral wall of the cranium. It is situated between the occipital behind, the parietal above, the frontal in front, and the sphenoid below.

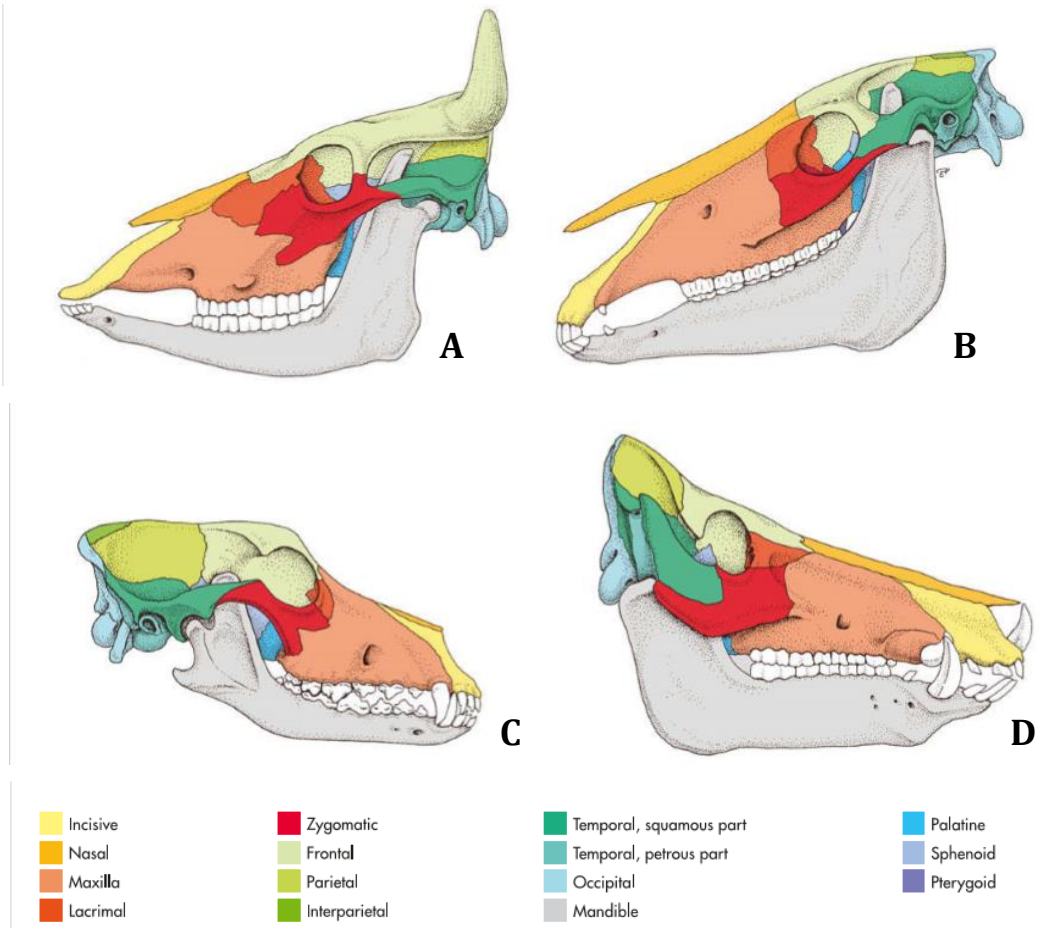


Figure 2.0: Skull of the Ox (A), Horse (B), Dog (C) and Pig (D) showing cranial and facial bones.

Nasal (Paired) – It is rostral to the frontal bones and dorsal to the maxilla and premaxilla bones; forming the greater part of the roof of the nasal cavity.

Maxilla (Paired) – This is the principal bone of the upper jaw carrying the upper cheek teeth. It is situated on the lateral aspect of the face articulating with the nasal bone dorsally, premaxilla rostrally and lacrimal and malar bones caudally.

Premaxilla/incisive (Paired) – This bone is situated rostral to the maxilla and forms the rostral part of the upper jaw carrying the incissor teeth.

Lacrimal (Paired) – This is situated at the rostral part of the orbit and lateral wall of the face. It extends forward on the face to the caudal border of the maxilla.

Malar/Zygomatic (Paired) – This is placed rostrolateral between the medial lacrimal and the rostral maxilla.

Palatine (Single) – This is seen ventrally; situated on either side of the posterior nares (a large ventral opening), while forming the caudal margin of the hard palate.

Pterygoid (Paired) – This is seen ventrally, emanating from either side of the lateral margins of the posterior nares.

Vomer (Single) – This is medially situated on the floor of the nasal cavity. Only the caudal part can be seen ventrally dividing the posterior nares.

Turbinate (Paired) – This is attached to the medial walls of the nasal cavity. It can be vaguely seen from the cranial view and more appreciated when the nasal cavity is exposed.

Mandible (Single) – Is the largest and only moveable facial bone anchoring the lower teeth.

Hyoid (Single) – Placed between the mandibular rami in the life state. It's a single bone segmented into parts. N.B: Due to maceration, the hyoid may not be seen as a whole. Only individual bones making up this bone may be seen.

N.B: In order to fully understand and appreciate the bones of the skull, it will be better studied from 6 different views (Caudal, cranial, dorsal, ventral, lateral and medial).

INSTRUCTION:

Pick up the Skull of the **ruminant species (Bovine, Caprine, Ovine)** from the non-articulated bone collection to identify and study the features of the cranial and facial bones (via the above mentioned views) as described below:

DORSAL VIEW

Describing rostro-caudally, the following bones are prominent

Nasal

The paired nasal bone presents an elongated triangular outline, wide behind, pointed in front. Each presents two surfaces, two borders, a base, and an apex.

The *external or facial surface* is smooth and is convex transversely. The *internal or nasal surface* is smooth and concave from side to side. About in its middle it presents the dorsal turbinal crest, which is parallel with the inner border, and has the dorsal turbinal bone attached to it. Most of this surface faces into the nasal cavity.

The *internal or medial border* is straight, and meets the opposite bone at the nasal suture. The *external or lateral border* is irregular. Its rostral third is free and concurs with the nasal process in forming the naso-maxillary notch. Behind this it is scaly for articulation with the end of the nasal process, the maxilla, and the lacrimal, forming the naso-maxillary and naso-lacrimal sutures. In small ruminants (small and goat), the nasolacrimal suture is absent thereby creating a space, the frontal sinus.

The *base or caudal end* is beveled and overlaps the frontal bone, forming the naso-frontal suture.

The rostral process forms the *apex* which in the sheep and goat ends centrally. The Ox has two apices separated by a concave depression. The rostral process reaches beyond the bones located ventrally to it, thus forming the naso-incisive notch between the nasal and the incisive/premaxilla.

Frontal

The paired frontal bone is irregularly quadrilateral and consists of frontal (squamous), orbital, and temporal parts. The frontal (squamous) part is only seen in this dorsal view.

The *frontal (squamous) part* forms the basis of the forehead. It is separated from the temporal surface by the concave temporal line, which extends caudally as the external sagittal crest. At the junction with the orbital part, it extends to form the zygomatic process laterally which forms part of the dorsal margin of the orbit. Its external surface is nearly flat, smooth and subcutaneous presenting the supraorbital foramen and Supraorbital groove (absent in small ruminants). The internal surface enters into the formation of the cranial cavity and the frontal sinus. In horned ruminants, the caudal end of the frontal (squamous) part carries the paired cornual processes, which support the horn.
The principal connections of the frontal (squamous) part are as follows: (1) The medial border joins its fellow at the frontal suture, (2) The rostral border meets the nasal and lacrimal at the fronto-nasal and fronto-lacrimal sutures respectively, (3) Caudally, in the Ox, it meets the interparietal medially and parietal laterally. In small ruminants (Sheep and Goat), it meets with the parietal only.

Interparietal

A small part of the bone is seen dorsally in the Ox. It continues on the caudal aspect of the skull as a small triangular bone bounded by two parietals laterally and the occipital at its base. It is usually described as a single bone, although it ossifies from two chief lateral centers, and is sometimes distinctly paired in skulls of young animals.

N.B: The Premaxilla, maxilla, lacrimal and malar can also be seen dorsally but are more prominent laterally hence will be described when discussing the lateral view of the skull.



Figure 2.1: Bovine Skull (Horn and hornless), Dorsal view.
1, Nasal, 2, Frontal, 3, Zygomatic process, 4, Supraorbital foramen, 5, Interparietal, 6, Supraorbital groove, 7, Temporal line, 8, Cornual process.

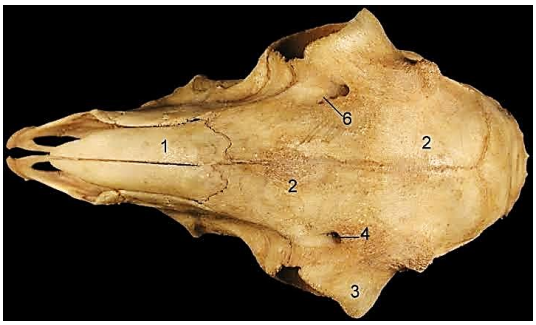


Figure 2.2: Caprine Skull, Dorsal view
1, Nasal, 2, Frontal, 3, Zygomatic process, 4, Supraorbital foramen, 6, Supraorbital groove.

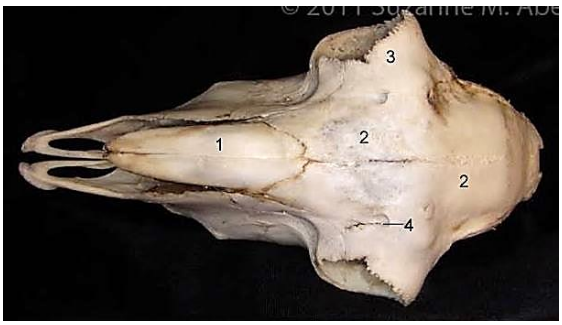


Figure 2.3: Ovine Skull, Dorsal view
1, Nasal, 2, Frontal, 3, Zygomatic process, 4, Supraorbital foramen, 6, Supraorbital groove.

Comparative Anatomy:

Equine (Horse):
The nasal bones are extensive forming the larger portion of the dorsal surface of the skull. Its apex ends centrally.
The *frontal bones* are not extensive. They occupy only one-third of the dorsal surface of the skull. The supraorbital groove is absent.

The paired *parietal bone* forms the greater part of the roof of the cranium; they unite in the median line, forming the sagittal suture. Each is quadrilateral in outline and has two surfaces and four borders. The rostral border joins the frontal bone at the parieto-frontal suture. The caudal border meets the occipital bone at the parieto-occipital suture. The parietal bone constitutes the upper part of the caudal wall and also enters into the formation of the temporal fossa, therefore each bone is made up of a caudal and lateral part.
The *Interparietal* which is also paired is placed between the two parietals.
Part of the occipital bone is seen dorsally forming the external occipital protuberance or nuchal crest.

Porcine (Pig):
The caudal part of the *nasal bone* presents a continuation of the supraorbital groove that took its origin from the supraorbital foramen on the frontal bone. The nasal bone articulates rostrally with the premaxilla but does not articulate with the lacrimal bone caudally. Its apex ends centrally.
The supraorbital foramen is located close to the rostral border of the frontal bone.
The demarcation (temporal line) between the dorsal and temporal parts of the *parietal* is concave. The *interparietal* fuses before birth with the Occipital.



Figure 2.4: Porcine skull, Dorsal view.
1, Nasal, 2, Frontal, 3, Zygomatic process, 4, Supraorbital foramen, 6, Supraorbital groove, 7, Temporal line, 9, Occipital crest.



Figure 2.5: Canine skull, Dorsal view.
1, Nasal, 2, Frontal, 3, Zygomatic process, 4, Parietal, 5, interparietal 6, External occipital crest.

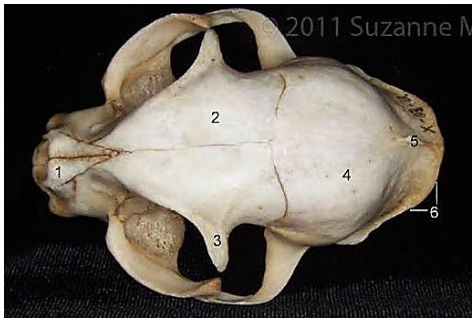


Figure 2.6: Feline skull, Dorsal view.

Canine (Dog):
The caudal border of the *nasal bone* i.e the base is pointed. The apex ends laterally. The nasal bone articulates rostrally with the premaxilla but does not articulate with the lacrimal bone caudally.
The supraorbital foramen is absent. The temporal line extends caudally as the external sagittal crest.
The *parietal* bone constitutes the upper part of the caudal wall and but doesn't enter into the formation of the temporal fossa. The interparietal is placed caudally in between the parietals.

Feline (Cat):
The nasal bone is similar to that of the dog but shorter.
The supraorbital foramen is absent.
The *parietal* bone constitutes the upper part of the caudal wall and also doesn't enter into the formation of the temporal fossa. The interparietal is placed caudally in between the parietals.

ACTIVITY: Sketch and label the dorsal view of the equine skull. Also compare the features of the dorsal view of the skull in these species using + for presence and – for absence.

Equine Skull, Dorsal view.

Features	Ox	Horse	Pig	Dog	Cat
Parietal					
Interparietal					
Supraorbital foramen					
Supraorbital groove					
Zygomatic process of fontal					
Occipital crest					
Temporal line					

CAUDAL VIEW

Interparietal

A small part of the bone is seen dorsally. It continues on the caudal aspect of the skull as a small triangular bone bounded by two parietals laterally and the occipital at its base. It is usually described as a single bone, although it ossifies from two chief lateral centers, and is sometimes distinctly paired in skulls of young animals. This bone is absent in the Sheep and Goat.

Parietal

The paired parietal presents a somewhat quadrilateral shape caudally above the occipital. It also presents a lateral part that forms part of the temporal fossa by articulating dorsally with the frontal (via the frontoparietal suture) and ventrally with temporal (via the parieto-temporal suture). In the Sheep and Goat, the Parietal does not appear paired. It presents as a single bone extending parts to the temporal fossa.



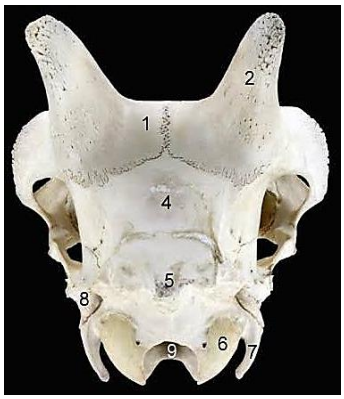


Figure 2.7: Bovine skull, Caudal view **Figure 2.8: Ovine skull, caudal view**

1, Frontal, 2, Cornual process, 3, Interparietal, 4, Parietal, 5, Squamous occipital, 6, Occipital condyle, 7, Paracondyloid/paramastoid process, 8, Temporal, 9, Foramen magnum.

Occipital

The Occipital bone is made up of three parts namely: Squamous, lateral and basilar. Only the Squamous and lateral parts are located on the caudal aspect of the skull.

Squamous part – This is the somewhat quadrilateral mass of the bone not entering the formation of the foramen magnum (Large opening through which the spinal cord). The outer surface is roughened for ligament and muscular attachment. While the inner surface is concave and presents surfaces which adapt it to the surface of the cerebellum.

Lateral part – This part surrounds the foramen magnum dorsally and laterally. It bears the occipital condyles, which articulate with the atlas. External to the condyle is the *paramastoid or paracondyloid process*, a strong flattened bar of bone which projects downward. Between the root of this process and the condyle is a smooth depression, the *condyloid fossa* which lodges the hypoglossal foramen for passage of the hypoglossal nerve.

Comparative Anatomy:

Equine (Horse):
The outer surface of the squamous part forms a prominent ridge called the occipital crest which also runs laterally downward and forward to join the temporal crest. The middle part of the occipital crest is called the external occipital protuberance. It is thick, transverse and forms the highest point of the skull. The inner surface of the squamous part of the occipital bone is concave and presents a deep central depression and two shallower lateral ones which adapt it to the surface of the cerebellum.

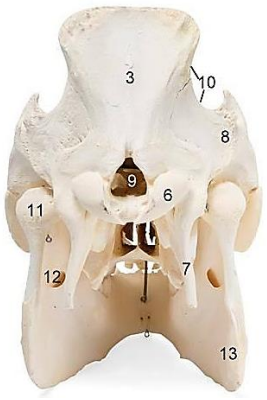


Figure 2.9: Porcine skull, caudal view.
3, Squamous occipital, 6, Occipital condyle, 7, paramastoid process, 8, Temporal, 9, Foramen magnum, 10, Temporal line, 11, Mandibular condyle, 12, Mandibular foramen, 13, ramus of mandible.

Porcine (Pig):
The outer surface of the squamous part forms a prominent ridge called the occipital crest which also runs laterally downward and forward to join the temporal crest. The Squamous part enters into the formation of the foramen magnum which is narrow. The Paramastoid process is very long.

Canine (Dog):
The outer surface of the squamous part forms a prominent ridge called the occipital crest which also runs laterally downward and forward to join the temporal crest. The Squamous part enters into the formation of the foramen magnum. The paramastoid process is the same height as the condyle.

Feline (Cat):
The outer surface of the squamous part forms a prominent ridge called the occipital crest which also runs laterally downward and forward to join the temporal crest. The Squamous part enters into the formation of the foramen magnum. The paramastoid process is the same height as the condyle.

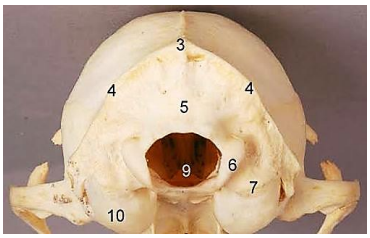
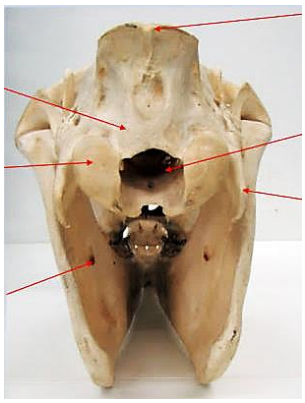


Figure 2.10: Feline skull, caudal view.
3, Occipital crest, 4, Temporal crest, 6, Occipital condyle, 7, paramastoid process, 9, Foramen magnum, 10, Tympanic bulla.

ACTIVITY:
Name the view _____ of the _____ bone of the _____species in the schematic presentation and label the pointed parts. Also sketch the caudal view of canine skull.

Canine skull, caudal view.



VENTRAL VIEW

Occipital

Basilar part – This is located on the ventro-caudal aspect of the skull and also forming part of the foramen magnum. The basilar part is a strong, somewhat prismatic bar which extends forward from the ventral margin of the foramen magnum. The lateral borders are thin and sharp, and form the inner margin of the jugular foramen. The cranial end attaches via a cartilage to the sphenoid bone in the young but fuses completely in the adult. On the ventral aspect of the junction are tubercles for the attachment of muscles of the head.

Temporal

The Temporal bone consists of two distinct parts, squamous and petrous. These parts are firmly fused in these species.

The squamous temporal is a shell-like plate which has two surfaces and four borders. These are prominent in the lateral view of the skull hence will be described later.
The wide caudal part of the squamous temporal presents on its ventral face; a convex surface for articulation with the condyle of the mandible behind which is the mandibular fossa. The fossa is limited behind by the retroarticular process. Behind this process is a fossa in which is the external opening of the parieto-temporal canal. The dorsal surface is concave and forms the outer boundary of the temporal fossa.

The *petrous temporal* is placed between the occipital behind and squamous temporal in front. The external surface is mainly concealed by the squamous temporal, but the following parts

can be identified: *The mastoid process, external auditory process, styloid process, tympanic bulla, and muscular process.*
The mastoid process is placed in the interval between the caudal process of the squamous temporal and the root of the paramastoid (or styloid) process of the occipital bone.

The external auditory (retrotympanic) process is a short tube of bone cranial to the mastoid process and caudal to the parieto-temporal canal. Its lumen, the external auditory meatus, conducts sound to the cavity of the middle ear (tympanum) in the dry skull.

The styloid process is a short rod which projects downward and forward ventral to the external auditory process. It is enclosed in a bony tube and connects to the hyoid bone via a bar of cartilage. The stylo-mastoid foramen is situated between the root of the styloid process and the mastoid process; it is the external opening of the facial canal, through which the facial nerve emerges.
The Tympanic bulla is a large considerable eminence situated centrally; it is thin-walled and encloses a cavity which is part of the tympanum. Its caudal surface forms the lateral boundary of the jugular foramen.
The muscular process' is a sharp spine which projects downward and forward from the rostral part of the typmpanic bulla.

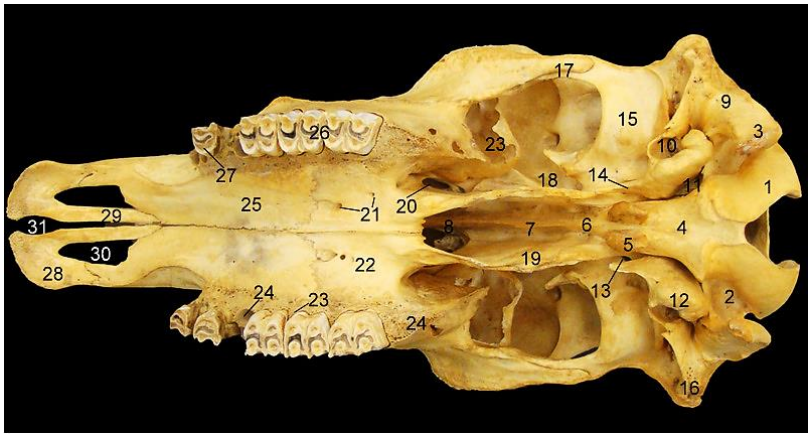


Figure 2.11: Bovine skull (Hornless), ventral view
1. Occipital condyle, 2, Condyloid fossa, 3, Paramastoid process, 4, Basilar part of Occipital, 5, Basilar tubercle, 6, Basisphenoid, 7, Pre-sphenoid, 8, Vomer, 9, Mastoid process, 10, Styloid process, 11, Jugular foramen, 12, Tympanic bulla, 13, Oval foramen, 14, Muscular process, 15, Convex surface for mandibular condyle articulation, 16, External auditory process, 17, Zygomatic arc, 18, Wing of sphenoid, 19, Pterygoid, 20, Lesser palatine foramen, 21, Greater Palatine foramen, 22, Horizontal part of palatine, 23, Alveolar process, 24, Maxillary tuberosity, 24, Alveoli, 25, Palatine process of Maxilla, 26, Molars, 27, Premolars, 28, Premaxilla, 29, Palatine process of premaxilla with interincissive suture, 30, Palatine fissure, 31, Interincissive fissure.



Figure 2.12: Bovine skull (Horned), ventral view.

Sphenoid

The Sphenoid bone consists of a central part (presphenoid), the body (Basisphenoid), two pairs of wings, and two pterygoid processes.

The pre and basi sphenoid are both fused in the adult animal. The caudal end of the presphenoid articulates with the rostral end of the Occipital bone (Basilar part). The dorsal or internal surface (in the cranial cavity) of the sphenoid presents the sella turcica or pituitary fossa for the lodgement of the pituitary gland. Its ventral surface is convex in the transverse direction while its rostral part is concealed to a large extent by the vomer and pterygoid bones. The rostral part of the internal surface presents the ethmoidal spine which joins the crista galli of the ethmoid bone.

The two pairs of wings present three foramina on either side. The larger middle foramen is called foramen orbitorotundum. Caudal to this foramen at about the middle of the basisphenoid is the oval foramen for the exit of cranial nerves. The smaller foramen rostral to the foramen orbitorotundum is the optic foramen. It should be noted that the presphenoid is raised higher than the basisphenoid.

The pterygoid processes arise from the temporal wings and the body. They project downward and forward, and curve outward at the lower part. The Pterygoid bone articulates with sphenoid at this part.

Pterygoid

The paired pterygoid bone is a narrow, thin, bent plate, situated on either side of the posterior nares. Each has two surfaces and two extremities. The internal surface is smooth, and forms part of the boundary of the posterior nares. The external surface articulates with the palatine, vomer, and sphenoid, concurring with the last in the formation of the pterygoid or Vidian canal. The cranial extremity is free, turned slightly outward, and forms a pointed part curving backward; the Hamulus, for attachment of muscle tendon.

Vomer

The vomer is composed of a thin lamina except caudally. It forms a narrow groove, in which the lower part of the perpendicular plate of the ethmoid bone and the nasal septal cartilage are received. The ventral border is thin and free dividing the posterior nares into right and left halves. The cranial extremity lies above the ends of the palatine processes of the premaxilla. The caudal extremity consists of two wings which extend outward covering part of the pre-sphenoid before laterally joining the palate and pterygoid bones.

Palatine

The paired palatine bone is situated on either side of the posterior nares, and forms the caudal part of the hard palate. Each is twisted so as to form a perpendicular and a horizontal part.

The perpendicular part is extensive and forms the outer boundary of the posterior nares. It presents for description, two surfaces, and three borders (caudal, dorsal and cranial).
The nasal or internal surface is concave and smooth.
The maxillary or external surface is convex and smooth.
The dorsal border is perforated by the sphenopalatine foramen rostrally and articulates with the sphenoid caudally. The inner side of the border curves inward to articulate with the vomer.
The caudal border articulates with the rostral border of the pterygoid. The cranial border joins rostrally to the medial surface of the maxilla.

The horizontal part is a narrow plate which forms the caudal part of the hard palate. It presents smooth nasal (dorsal) and palatine (ventral) surfaces. The medial border meets its fellow at the palatine suture. The cranial border joins the palatine process of the maxilla at the transverse palatine suture. Caudal to this suture in the Ox is the palatine foramen. The Palatine foramen is on the transverse palatine suture in the sheep and goat. The caudal border is concave and free; it gives attachment to the apouneurosis of the soft palate. Its lateral border meets with the medial surface of the maxilla.

Maxilla

The palatine process, alveolar process and maxillary tuberosity of each maxilla can be appreciated ventrally.

The alveolar process encloses the cavities for the teeth, the dental alveoli and on its free border, the alveolar margin. The alveoli are separated by transverse interalveolar septa. The interalveolar margin extends between the canine and first cheek tooth. Behind the last alveolus is a rough area, the alveolar/maxillary tuberosity. Between this tuberosity and the vertical part of the palatine is the lesser palatine foramen.

The Palatine process presents a plate-like feature which projects horizontally from the alveolar processes. It forms the greater part of the basis of the hard palate. Its medial border joins its opposite at the median palatine suture. The caudal part of the lateral border is straight while its cranial part is concave. In the sheep and goat, the palatine groove extends from the palatine foramen and fades. Rostrally the palatine process articulates with parts of the premaxilla (incisive bone) in the formation of the bony palatine fissure. The nasal surface of the palatine process forms the nasal crest to which the vomer attaches.

Premaxilla/incisive

The body, palatine process and alveolar process of the premaxilla can be seen ventrally. The body is however more prominent in the lateral view of the skull, hence will be described later.

The palatine process is a thin plate which forms the anterior part of the basis of the hard palate. Its nasal or dorsal surface has a longitudinal ridge which forms with that of the other side a groove for the septal cartilage. The palatine or ventral surface is flat. The internal border is serrated and meets its fellow at the median palatine suture, leaving a cleft at the

interincisive suture. The lateral border is separated from the maxilla and the nasal process by the palatine fissure. The caudal extremity fits into the interval between the vomer and the palatine process of the maxilla.

The alveolar process of the incisive bone joins the maxilla caudally forming the interalveolar margin. Since there are neither upper incisor teeth, nor a canine tooth in ruminants, the dental alveoli for these teeth are lacking in these species.

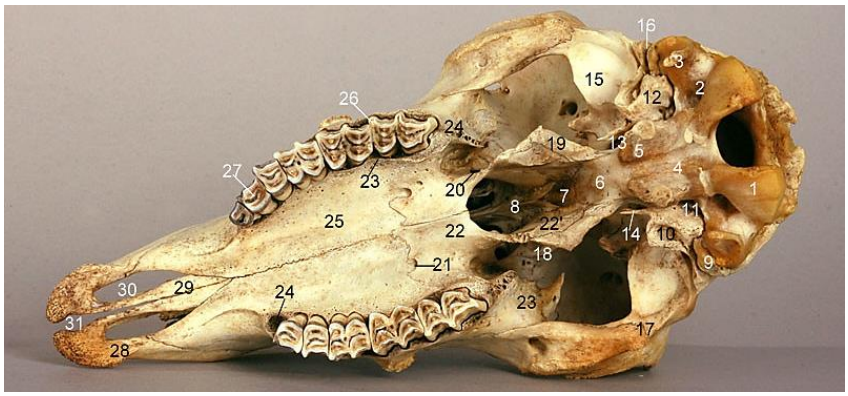


Figure 2.13: Ovine skull (Hornless), ventral view

1. Occipital condyle, 2, Condyloid fossa, 3, Paramastoid process, 4, Basilar part of Occipital, 5, Basilar tubercle, 6, Basisphenoid, 7, Pre-sphenoid, 8, Vomer, 9, Mastoid process, 10, Styloid process, 11, Jugular foramen, 12, Tympanic bulla, 13, Oval foramen, 14, Muscular process, 15, Convex surface for mandibular condyle articulation, 15' Mandibular fossa, 15'', Parietotemporal canal, 15''', Retroarticular process, 16, External auditory process, 17, Zygomatic arc, 18, Wing of sphenoid, 19, Pterygoid, 20, Lesser palatine foramen, 21, Greater Palatine foramen, 22, Horizontal part of palatine, 23, Alveolar process, 24, Maxillary tuberosity, 24, Alveoli, 25, Palatine process of Maxilla, 26, Molars, 27, Premolars, 28, Premaxilla, 29, Palatine process of premaxilla with interincissive suture, 30, Palatine fissure, 31, Cleft at Interincissive suture.

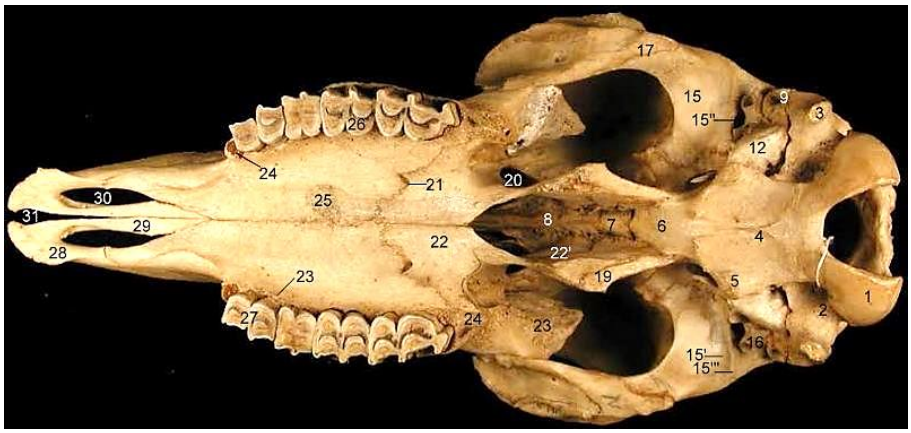


Figure 2.14: Caprine Skull, ventral view.

Hyoid

The hyoid bone is situated chiefly between the rami of the mandible, but its upper part extends somewhat further back. It is attached to the petrous temporal bones by rods of cartilage, and supports the root of the tongue, the pharynx, and larynx. It consists of a body, a lingual process, and three pairs of cornua.

The body or basihyoid is a short transverse bar. The upper surface is concave and smooth in its middle, and presents at each end a convex facet or tubercle for articulation with the small cornu. The lower surface is slightly roughened for muscular attachment. The cranial border carries medially the lingual process. The caudal border is concave and smooth in its middle, and carries on either side the thyroid cornu. The body, the lingual process, and the thyroid processes are fused together, and may be compared to a spur or a fork with a very short handle.

The lingual process projects forward medially from the body, and is embedded in the root of the tongue during life. It is compressed laterally and has a blunt-pointed free end.

The thyroid cornua or thyrohyoids extend backward and upward from the lateral parts of the body. Their caudal ends are connected with the cranial cornua of the thyroid cartilage of the larynx.

The small cornua or keratohyoids are short rods which are directed upward and forward from either end of the upper surface of the body. Each is somewhat constricted in its middle part and has slightly enlarged ends. The lower end has a small concave facet which articulates with the body. The upper end articulates with the great cornu, or with the middle cornu when present.

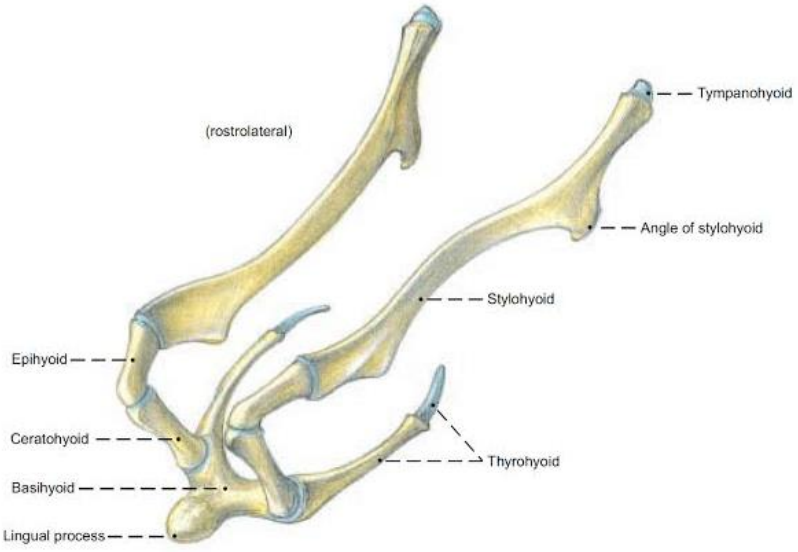


Figure 2.15: Bovine Hyoid

The great cornua or stylohyoids are much the largest parts of the bone. They are directed upward and backward, and are connected above with the base of the petrous temporal bones. Each is a thin plate, which is slightly curved in its length. The upper extremity is large and forms two angles; the upper angle is connected by a rod of cartilage with the hyoid process of the petrous temporal bone; the lower angle is somewhat thickened and rough for muscular attachment. The lower extremity is small, and articulates with the small or the middle cornu.

The middle cornua or epihyoids are small wedge-shaped pieces or nodules interposed between the small and great cornua. They are usually transitory, and unite with the great cornua in the adult.

Comparative Anatomy:

Equine (Horse):

The sharp and thin lateral borders of the basilar part of *occipital* form the deep petro-occipital fissure together with the petrous part of the temporal bone where the foramen lacerum is built.

The squamous and petrous parts of *temporal* are not firmly fused as in ruminants. The articular tubercle of the squamous temporal is a transversely elongated condyle. The tympanic bulla is not bulb-like.

The epihyoid is fused with the stylohyoid.

The caudal border of each wing of *sphenoid* forms the rostral border of the foramen lacerum. It forms three notches, the carotid notch medially, the oval notch and the spinous notch laterally. The wing of the basisphenoid is perforated by the alar canal. It originates with the caudal alar foramen and terminates with the rostral alar foramen.

The horizontal part of the palatine is very short. The Palatine foramen resides at the border between the palatine bone and the palatine process of maxilla.

The palatine process of the maxilla is extensive. The palatine groove extends from the palatine foramen but fades. The interalveolar margin is long. The interincissive suture is firmly fused.

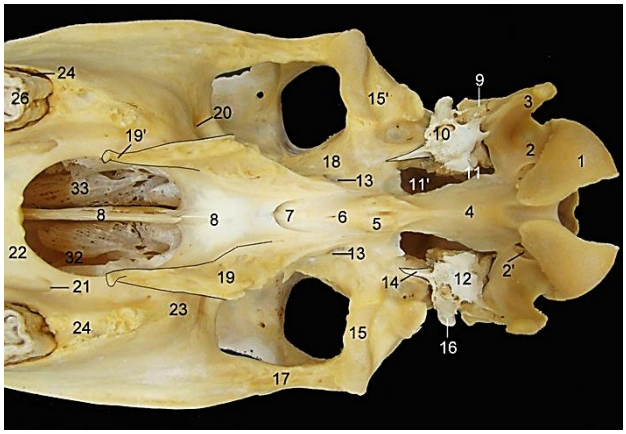


Figure 2.16: Equine Skull, cranio-ventral view

1. Occipital condyle, 2, Condyloid fossa, 3, Paramastoid process, 4, Basilar part of Occipital, 5, Basilar tubercle, 6, Basisphenoid, 7, Pre-sphenoid, 8, Vomer, 9, Mastoid process, 10, Styloid process, 11, Jugular foramen, 11', Foramen lacerum, 12, Tympanic bulla, 13, Oval foramen, 14, Muscular process, 15, Convex surface for mandibular condyle articulation, 15' Mandibular fossa, 16, External auditory process, 17, Zygomatic arc, 18, Wing of sphenoid, 19, Pterygoid, 19', Hamulus of the Pterygoid, 20, Lesser palatine foramen, 21, Greater Palatine foramen, 22, Horizontal part of palatine, 26, Molars, 32, Posterior nares, 33, Turbinate.

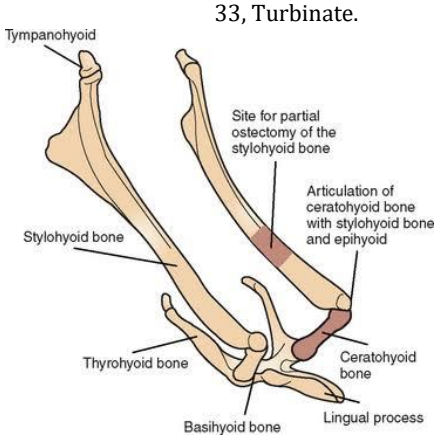


Figure 2.17: Equine Hyoid bone

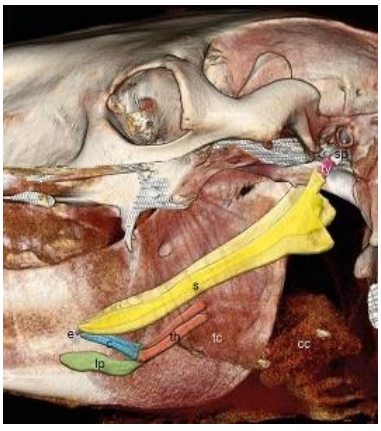


Figure 2.18: Hyoid bone location

Porcine (Pig):

The squamous and petrous parts of *temporal* are not firmly fused as in ruminants. The articular tubercle of the squamous temporal is a transversely elongated condyle.

Styloid process of petrous temporal is absent

The hyoid articulates with the nuchal process of the squamous temporal bone. The epihyoid is replaced by the epihyoid ligament.

The muscular process is not prominent.

The Palatine foramen is on the caudal part of the palatine process of maxilla.

The palatine groove extends from the palatine foramen to the palatine fissure.

The interalveolar margin is short.

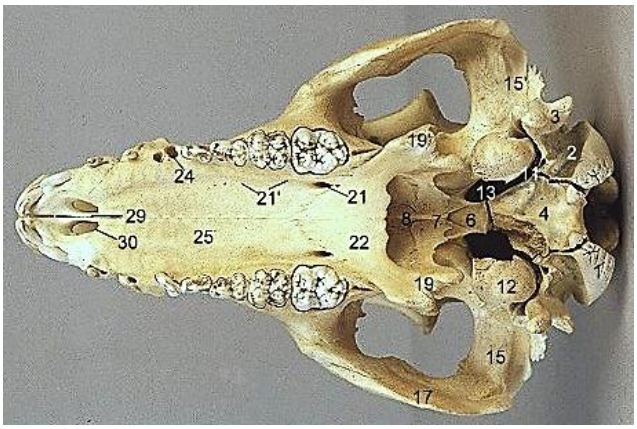


Figure 2.19: Porcine skull, ventral view.

1. Occipital condyle, 2, Condyloid fossa, 3, Paramastoid process, 4, Basilar part of Occipital, 5, Basilar tubercle, 6, Basisphenoid, 7, Pre-sphenoid, 8, Vomer, 9, Mastoid process, 10, Styloid process, 11, Jugular foramen, 12, Tympanic bulla, 13, Oval foramen, 14, Muscular process, 15, Convex surface for mandibular condyle articulation, 15' Mandibular fossa, 16, External auditory process, 17, Zygomatic arc, 19, Pterygoid, 19', Hamulus of the Pterygoid, 21, Greater Palatine foramen, 22, Horizontal part of palatine, 24, Alveoli, 25, Horizontal part of palatine, 29, Palatine process of premaxilla with interincissive suture, 30, Palatine fissure.

Canine (Dog):

Styloid process of petrous temporal is absent.

The hyoid articulates with the mastoid process of the petrous temporal bone

The Tympanohyiod is composed of a fibrous tissue, the epihyoid is cylindrical. The wing of sphenoid presents independently, the oval foramen, spinous foramen and carotid canal. These replace the foramen lacerum seen in the horse.

The articular tubercle is absent.

The stylomastoid foramen is situated between the mastoid process and the tympanic bulla.

The muscular process is not prominent.

The Palatine foramen resides at the border between the palatine one and the palatine process of maxilla.

The palatine groove extends from the palatine foramen to the palatine fissure.

The interalveolar margin is short.

The interincissive fissure is firmly fused.

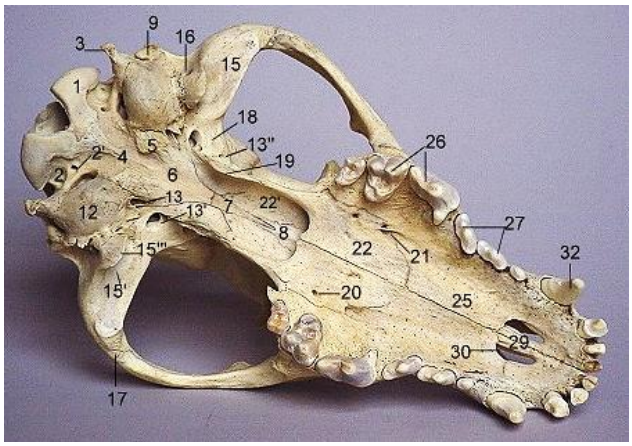


Figure 2.20: Canine skull, ventral view.

Feline (Cat):
Similar to the Dog.
Palatine groove is absent.
All parts of the hyoid are almost the same size.
Lingual process is absent.

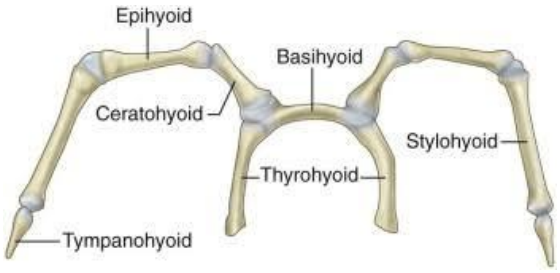
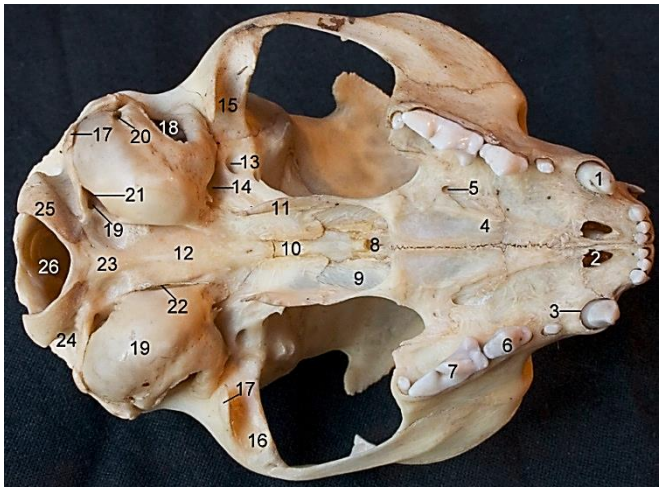


Figure 2.21: Feline Hyoid bone

ACTIVITY:

Label the following numbered parts of the Feline skull



1_____
4_____
5_____
8_____
12_____
13_____
14_____
17_____
19_____
20_____
21_____
22_____
24_____
26_____

LATERAL VIEW

Frontal

The *temporal part* of the frontal bone is separated from the orbital part by the deep sphenoidal notch, which is occupied by the orbital wing of the sphenoid. Its external surface forms part of the inner wall of the temporal fossa.

The *orbital part* of the frontal bone forms the major part of the inner wall of the orbital cavity. It is separated from the frontal part by its dorsal border; the dorso-caudal part of the orbital margin. Its external or orbital surface is concave and smooth, and presents dorsally the continuation of the supraorbital foramen. The ventral border meets with the orbital wing of the sphenoid. Dorsal to the border is the ethmoidal or internal orbital foramen. The internal surface faces into the frontal sinus and gives attachment to the lateral mass of the ethmoid.

Laterally, the orbital and temporal part of the frontal bone forms the spheno-frontal suture with the orbital wing of the sphenoid and the Parieto-frontal suture with the temporal part of the parietal respectively. Also, the extremity of the supraorbital process unites with the frontal process of the malar bone.

Temporal

The external surface of the squamous temporal is concave, and enters into the formation of the temporal fossa. From its lower part there springs the zygomatic process, which forms the external boundary of the temporal fossa. The process is directed outward, turns forward, becomes narrower, and twisted. Its cranial end is pointed and joins the zygomatic process of the malar bone, with which it forms the zygomatic arch.
The dorsal border of the squamous temporal articulates with the occipital, forming the occipito-temporal suture. The cranial and ventral border joins the temporal wing of the sphenoid at the spheno-squamous suture. The caudal border unites with the petrous temporal bone forming the caudal (occipital) process.

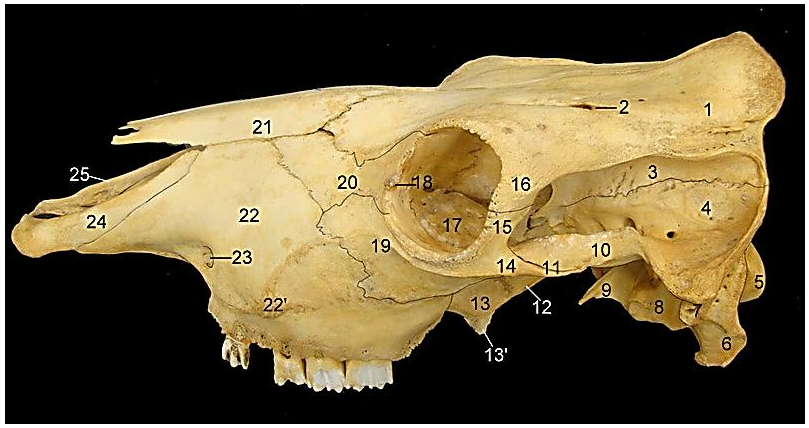


Figure 2.22: Bovine skull (Hornless), Lateral view
1, Frontal, 2, Supraorbital foramen and groove, 3, Parietal, 4, Temporal fossa, 5, Occipital condyle, 6, Paramastoid process, 7, external auditory process, 8, Tympanic bulla, 9, Muscular process, 10, Zygomatic process of Temporal, 11, Zygomatic arch, 12, Pterygoid, 13, Palatine, 13' Hamulus of pterygoid, 14, Zygomatic process of Malar, 15, Frontal process of Malar, 16, Supraorbital process, 17, Lacrimal bulla, 18, Lacrimal fossa, 19, Malar, 20, Lacrimal, 21, Nasal, 22, Maxilla, 22', Facial crest, 23, Infraorbital foramen, 24, Premaxilla, 25, Nasal process of premaxilla.

Malar (Zygomatic)

Each malar bone is irregularly triangular in outline and presents three surfaces (facial, orbital and nasal), three borders (rostral, dorsal and ventral) and two processes (frontal and zygomatic).
The facial surface is smooth, slightly convex, wide in front, and narrow behind. At its lower part it presents the facial crest, which is continuous in front with the similar ridge on the maxilla and behind with the zygomatic process of the temporal.
The orbital surface is separated from the facial surface by the concave orbital margin. It is concave and smooth, and forms part of the lower and front wall of the orbit.
The nasal surface is concave and faces into the maxillary sinus.
The dorsal border articulates with the lacrimal chiefly, the rostral and ventral borders articulate with the maxilla.

Caudally, the malar bone extends the frontal process (articulates with the zygomatic process of the frontal bone to form the supraorbital margin) and the zygomatic process (articulates with the zygomatic process of the temporal to form the zygomatic arch).



Figure 2.23: Bovine skull (Horn) dorsolateral view

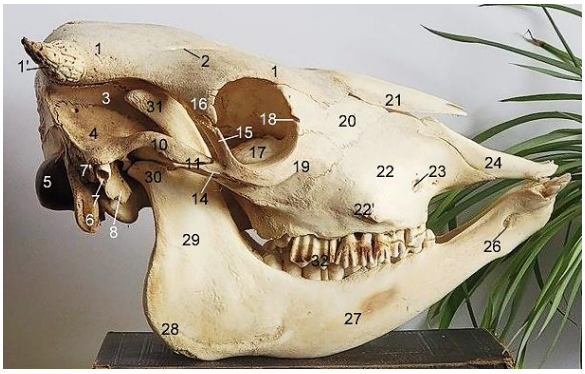


Figure 2.24: Bovine skull (Horn) lateral view.

1, Frontal, 1', Cornual process, 2, Supraorbital foramen and groove, 3, Parietal, 4, Temporal fossa, 5, Occipital condyle, 6, Paramastoid process, 7, external auditory process, 8, Tympanic bulla, 9, Muscular process, 10, Zygomatic process of Temporal, 11, Zygomatic arch, 12, Pterygoid, 13, Palatine, 13' Hamulus of pterygoid, 14, Zygomatic process of Malar, 15, Frontal process of Malar, 16, Supraorbital process, 17, Lacrimal bulla, 18, Lacrimal fossa, 19, Malar, 20, Lacrimal, 21, Nasal, 22, Maxilla, 22', Facial crest, 23, Infraorbital foramen, 24, Premaxilla, 25, Nasal process of premaxilla, 26, Mental foramen, 27, Body of mandible, 28, Angle of mandible, 29, Ramus of mandible, 30, Mandibular condyle, 31, Coronoid process.

Lacrimal

Each lacrimal bone presents three surfaces (facial, orbital and nasal) and a circumference (borders).
The orbital and facial surfaces are divided by the orbital margin.
The orbital surface is triangular in outline, smooth and concave; it forms part of the inner and front wall of the orbit. Near the orbital margin it presents a funnel-like fossa for the lacrimal sac, which is the entrance to the osseous lacrimal canal. Behind this is a depression. It also bears the expanded thin-walled lacrimal bulla ventrally, which contains an extension of the maxillary sinus.
The facial surface is more extensive, and has the form of an irregular pentagon.
The nasal or internal surface faces into the frontal and maxillary sinuses.
The circumference articulates dorsally with the frontal and nasal bones, ventrally with the malar, cranially with the maxilla, and caudally with the frontal in the orbit..

N.B: In the goat, a large naso-lacrimal fissure separates the point of articulation between the nasal and lacrimal bones.

Maxilla

Each maxillae may be divided into a body and two processes. The body presents two surfaces (facial and nasal), three borders (dorsal, caudal and ventral), and two extremities. The processes (alveolar and palatine) have been discussed earlier.

The external or facial surface has on its caudal part; a horizontal ridge, known as the facial or zygomatic crest. A little in front of the cranial end of the crest is the infraorbital foramen; the external opening of the infraorbital canal which extends almost horizontally from the maxillary foramen to the infraorbital foramen.
The internal or nasal surface is concave; it forms the greater part of the lateral wall of the nasal cavity. Its upper part is crossed obliquely by the shallow lacrimal groove, which contains the naso-lacrimal duct. Below the groove is the ventral turbinal crest, to which the dorsal turbinate bone is attached.

The dorsal border is irregular and scaly, articulating with the nasal process of the premaxilla. The caudal border is beveled articulating caudo-dorsally and caudo-ventrally with the lacrimal and malar bones respectively.
The ventral or alveolar border is thick and presents alveolar processes (This has been discribed earlier).

The cranial extremity is pointed. It joins the premaxilla to form the dorsal border of the diastema.
The caudal extremity forms a rounded prominence, the alveolar/maxillary tuberosity. Internal to the tuberosity is a deep cavity, the maxillary hiatus, in which are three foramina. The upper one, (1) the maxillary foramen, leads into the infraorbital canal. The lower one, the (2) posterior palatine foramen, is the entrance to the palatine canal. The (3) spheno-palatine foramen perforates the inner wall of the hiatus and opens into the nasal cavity.

Premaxilla

The body is the thick cranial part. Its labial or dorsal surface is convex and smooth, and is related to the upper lip. The palatine or ventral surface is straight or slightly concave.

The alveolar process of the incisive bone joins the maxilla caudally forming the interalveolar margin.

The nasal process projects backward and upward from the body, forming here the lateral wall of the nasal cavity. The two surfaces, facial and nasal, are smooth. The dorsal border is free, thick, and smooth. The ventral border joins the maxilla. As stated earlier, since there are neither upper incisor teeth, nor a canine tooth in ruminants, the dental alveoli for these teeth are lacking in these species.

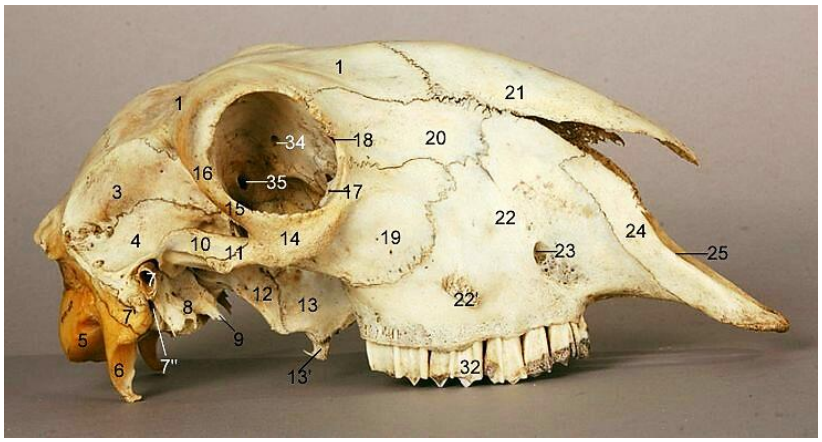


Figure 2.25: Ovine skull (Hornless), lateral view.



Figure 2.26: Caprine skull (Horn), lateral view.

1, Frontal, 1', Cornual process, 2, Supraorbital foramen and groove, 3, Parietal, 4, Temporal fossa, 5, Occipital condyle, 6, Paramastoid process, 7, external auditory process, 8, Tympanic bulla, 9, Muscular process, 10, Zygomatic process of Temporal, 11, Zygomatic arch, 12, Pterygoid, 13, Palatine, 13' Hamulus of pterygoid, 14, Zygomatic process of Malar, 15, Frontal process of Malar, 16, Supraorbital process, 17, Lacrimal bulla, 18, Lacrimal fossa, 19, Malar, 20, Lacrimal, 21, Nasal, 22, Maxilla, 22', Facial crest, 23, Infraorbital foramen, 24, Premaxilla, 25, Nasal process of premaxilla, 26, Mental foramen, 27, Body of mandible, 28, Angle of mandible, 29, Ramus of mandible, 30, Mandibular condyle, 31, Coronoid process, 32, teeth, 34, Supraorbital foramen, 35, Ethmoidal foramen.

Mandible

The mandible is the largest and the only movable bone of the face. It is usually described as a single bone with two halves. It carries the lower teeth, and articulates by its condyles with the squamous temporal on either side. Each half consists of a body and ramus joined at an angle. Both halves extend from the fused rostral end, diverging to enclose the sub-maxillary or mandibular space.

The body is the horizontal part of the mandible that bears the teeth. Its rostral or incisive part contains the incisors while caudal or molar part contains the cheek teeth.
The rostral or incisive part presents two surfaces and a border.
The lingual or dorsal surface is smooth and slightly concave. It is marked by a median furrow which indicates the position of the primitive mandibular symphysis.

The labial or mental surface is convex. Just below the interalveolar margin or diastema (space between the incisive tooth and the first cheek tooth), it bears the mental foramen which is the external opening of the mandibular or inferior dental canal.
The curved alveolar border presents alveoli for the incisor teeth.
The caudal or molar part presents two surfaces and two borders.
The external or lateral surface is smooth and slightly convex from edge to edge. The internal or medial surface is smooth and presents shallow depressions or fossae for muscular attachment.
The dorsal border contains alveolar processes and alveoli for cheek teeth (premolar and molar) implantation. The ventral border of the mandibular body is marked by a smooth indentation, the facial notch, where the facial vessels and the parotid duct curve around the bone.

The ramus is the vertical part of the mandible. It presents two surfaces, two borders and a dorsal extremity.
The lateral surface is smooth and characterized by the masseteric fossa, while its medial surface is characterized by the pterygoid fossa and also bears the mandibular foramen (caudal opening of the mandibular canal).
The dorsal extremity comprises the coronoid process in front and the condyle behind, the two being separated by the mandibular notch, through which the nerve to the masseter muscle passes. The coronoid process is thin transversely and slightly curved. It projects upward in the temporal fossa, and furnishes insertion to the temporal muscle. The condyle is elongated transversely and articulates with the squamous temporal through the medium of an articular disc. The part below the condyle is usually termed the neck. The angle of the mandible is the curved caudo ventral part of the ramus.



Figure 2.27: Equine mandible, dorso-lateral view.



Figure 2.29: Canine mandible, lateral view.

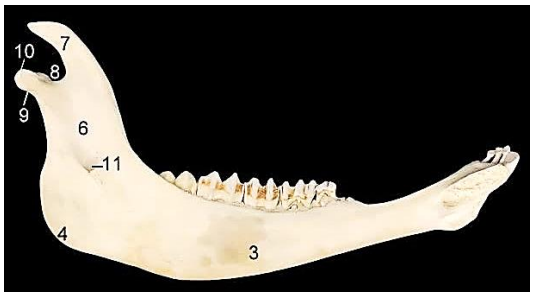


Figure 2.28: Bovine mandible, medial view

1, Mental foramen, 2, Fused rostral end, 3, body, 4, Angle, 5, Ramus & masseteric fossa, 6, Pterygoid fossa, 7, coronoid process, 8, Mandibular notch, 9, neck, 10, mandibular condyle, 11, Mandibular foramen.

Comparative anatomy:

Equine (Horse):
The zygomatic process of the frontal extends downward to articulate with the zygomatic process of the temporal bone. The ethmoidal foramen opens on the border between the frontal and sphenoid bone.
The frontal process of the malar is absent.
The ventral surface of the body of the premaxilla bears the alveolar process which contains alveolus for the incisor teeth.
The rostral part of the body of mandible bears a caudal alveoli for canine teeth, hence the interalveolar margin (diastema) is short.

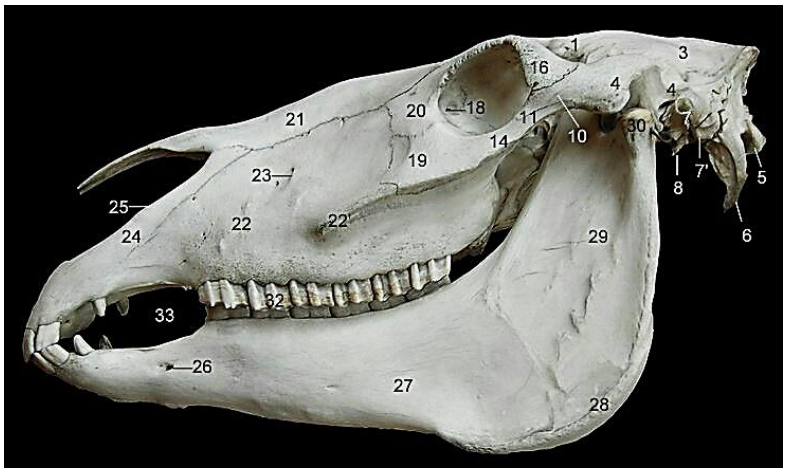


Figure 2.30: Equine skull, lateral view.

1, Frontal, 2, Supraorbital foramen and groove, 3, Parietal, 4, Temporal fossa, 5, Occipital condyle, 6, Paramastoid process, 7, external auditory process, 8, Tympanic bulla, 9, Muscular process, 10, Zygomatic process of Temporal, 11, Zygomatic arch, 13, Palatine, 14, Zygomatic process of Malar, 16, Supraorbital process, 17, Lacrimal bulla, 18, Lacrimal fossa, 19, Malar, 20, Lacrimal, 21, Nasal, 22, Maxilla, 22', Facial crest, 23, Infraorbital foramen, 24, Premaxilla, 25, Nasal process of premaxilla, 26, Mental foramen, 27, Body of mandible, 28, Angle of mandible, 29, Ramus of mandible, 30, Mandibular condyle, 33, interalveolar space/Diastema

Porcine (Pig):
The zygomatic process of the frontal does not extend downward to meet the frontal process of malar. Hence its orbital margin is incomplete.
The dorsal border of the squamous temporal articulates with the parietal, forming the parieto-temporal suture.
The lacrimal bone does not articulate with the nasal.
Distinct facial crest ends at the canine fossa.
The labial surface of the body of the premaxilla bears the alveolar process which contains alveolus for the incisor teeth.

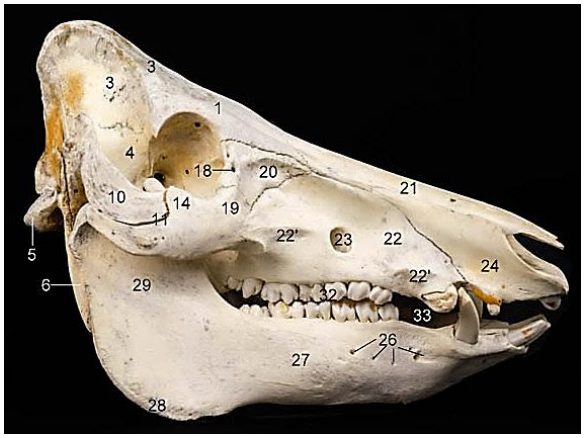


Figure 2.31: Porcine skull, lateral view.

The interalveolar margin is short.
The rostral part of the body of mandible bears a caudal alveoli for canine teeth. The mental foramen consists of five openings.

Canine (Dog):
The zygomatic process of the frontal is absent. Hence the dorsal margin of the orbit is formed by the orbital ligament.
The dorsal border of the squamous temporal articulates with the parietal, forming the parieto-temporal suture.
The lacrimal bone is small and does not articulate with the nasal.
Facial crest is absent.
The labial surface of the body of the premaxilla bears the alveolar process which contains alveolus for the incisor teeth. The interalveolar margin is very short.
The rostral part of the body of mandible bears a caudal alveoli for canine teeth. The mental foramen on lateral surface is ventral to the first cheek tooth and consists of two to three openings. The angle of the mandible extends a hook-like process; the angular process.

Feline (Cat):
The zygomatic process of the *frontal bone* is present (due to the ossification of part of the orbital ligament) but doesn't meet the zygomatic arch which also makes the bony orbital margin incomplete. The dorsal border of the squamous temporal articulates with the parietal, forming the parieto-temporal suture.
The lacrimal bone is small and does not articulate with the nasal.
Facial crest is absent.
The labial surface of the body of the premaxilla bears the alveolar process which contains alveolus for the incisor teeth. The interalveolar margin is short.
The rostral part of the body of mandible bears a caudal alveoli for canine teeth. The mental foramen on lateral surface is ventral to the first cheek tooth and consists of two to three openings. The angle of the mandible extends a hook-like process; the angular process.

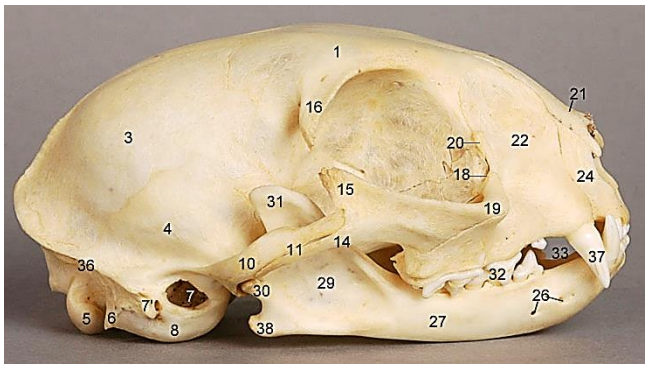
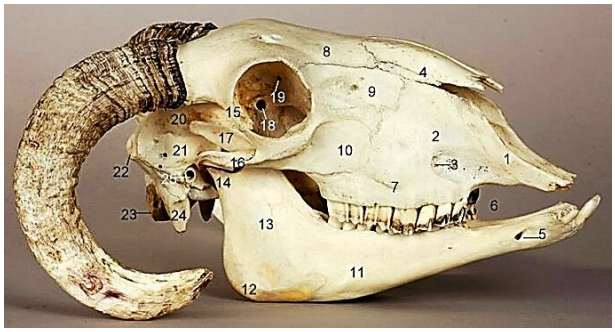


Figure 2.32: Feline skull

1, Frontal, 3, Parietal, 4, Temporal, 5, Occipital condyle, 6, Paramastoid process, 7, External auditory meatus, 8, Tympanic bulla, 10, Zygomatic process of Temporal, 11, Zygomatic arch, 14, Zygomatic process of Malar, 15, Frontal process of the Malar, 16, Supraorbital process, 18, Lacrimal fossa, 19, Malar, 20, Lacrimal, 21, Nasal, 22, Maxilla, 24, Premaxilla, 26, Mental foramen, 27, Body of mandible, 29, Ramus of mandible, 30, Mandibular condyle, 33, interalveolar space/Diastema, 36, Occipital crest, 37, Canine tooth, 38, Angular process.

ACTIVITY: Sketch and label the lateral view of the canine skull. Label the numbered parts of the skull of _____ species. Also compare the features of the lateral view of the skull in these species using + for presence and – for absence.

Canine skull, lateral view.



1_____
3_____
5_____
6_____
9_____
13_____
14_____
15_____
18_____
19_____

Features	Ox	Horse	Pig	Dog	Cat
Facial crest					
Incomplete orbit margin					
infraorbital foramen					
Frontal process of Malar					
Angular process					

INTERNAL AND MEDIAL VIEWS

Ethmoid

The Ethmoid can only be fully viewed and appreciated when the occipital, parietal and part of the frontal bones are removed. A part of the bone can also be seen when the skull is medially sectioned.

The Ethmoid consists of four parts—the cribriform plate, two lateral masses, and the perpendicular plate.

The *cribriform plate* is a sieve-like partition between the cranial and nasal cavities. Its margin joins the orbital wings of the sphenoid laterally, and the cranial plate of the frontal bones dorsally. Its caudal surface is divided into two parts by a median ridge, the crista galli, which is

the intracranial portion of the perpendicular plate. Each half forms a deep oval cavity, the ethmoidal or olfactory fossa, which lodges the olfactory bulb.
The plate is perforated by numerous small foramina for the passage of the olfactory nerve filaments, and on either side is the much larger ethmoidal foramen.

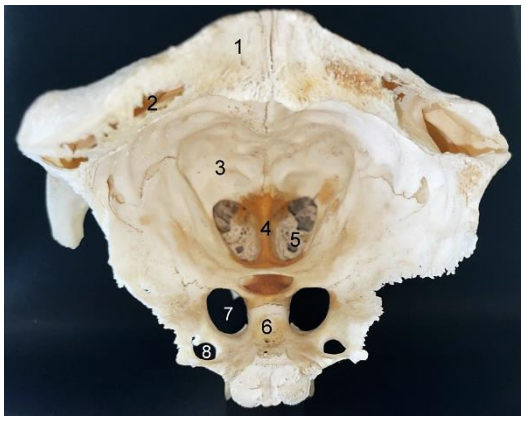


Figure 2.33: Bovine cranial cavity showing the caudal view of ethmoid.
1, Frontal bone, 2, Frontal sinus, 3, Ethmoid, 4, Crista galli, 5, Cribiform plate, 6, Sphenoid, 7, Foramen orbitorotundum, 8, Optic foramen,

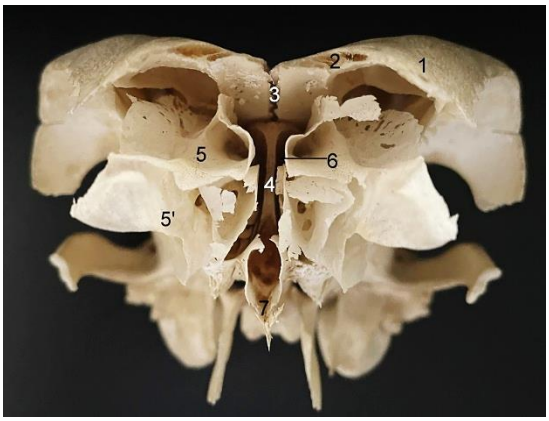


Figure 2.34: Bovine ethmoid (cranial view).
1, Frontal, 2, Frontal sinus, 3, Interfrontal suture, 4, Perpendicular plate, 5, 5', Ethmoturbinates, 6, Ethmoidal sinus, 7, Vomer.

The *perpendicular plate* forms the caudal part of the nasal septum. It divides the cribiform plate into two equal halves; projecting into the cranial cavity as the crista galli. This plate can be well appreciated when viewed medially.

The *lateral masses* are located lateral to the cribriform plates. The masses are called ethmoturbinates and are made up of scroll like plates attached to the cribiform plate. The ethmoturbinates are separated from each other by narrow spaces termed meatuses which communicate with the nasal cavity.

Turbinate

These delicate, scroll-like bones are four in number. Attaching to the lateral walls of the nasal cavity, they project into it greatly diminishing its extent. Each is composed of a very thin lamina, cribriform in many places, and covered on both sides with mucous membrane in the fresh state. They are arranged in two pairs, dorsal and ventral.

The dorsal or naso-turbinate is somewhat cylindrical in form, small at its cranial part, and flattened transversely. It is attached to the turbinal crest of the nasal bone and the nasal plate of the frontal bone. The cranial part is rolled like a scroll one and a half times, thus inclosing a cavity which communicates with the middle nasal meatus. The arrangement is best seen on a cross section. The caudal part is not rolled, but its lower border is attached to the lateral nasal wall, thus helping to enclose a large space which is part of the frontal sinus. This cavity is

separated from that of the scroll-like part by a transverse septum. The internal surface is flattened, and is separated from the septum nasi by a narrow interval, the common meatus. Another narrow passage, the dorsal nasal meatus, separates the upper surface from the roof of the nasal cavity. The space between the lower surface and the ventral turbinate is the middle nasal meatus. The cranial extremity is prolonged toward the nostril by two small bars of cartilage.

The ventral or maxillo-turbinal bone is shorter and smaller caudally than the upper one. It is attached to the ventral turbinal crest, and consists of a cranial coiled and a caudal uncoiled portion. The ventral and caudal borders of the caudal part are attached to the maxilla, thus helping to enclose a cavity which is part of the maxillary sinus. The lower surface is separated from the floor of the nasal cavity by the ventral nasal meatus which is much larger than the other nasal passages. The cranial extremity is prolonged to the nostril by a bar of cartilage

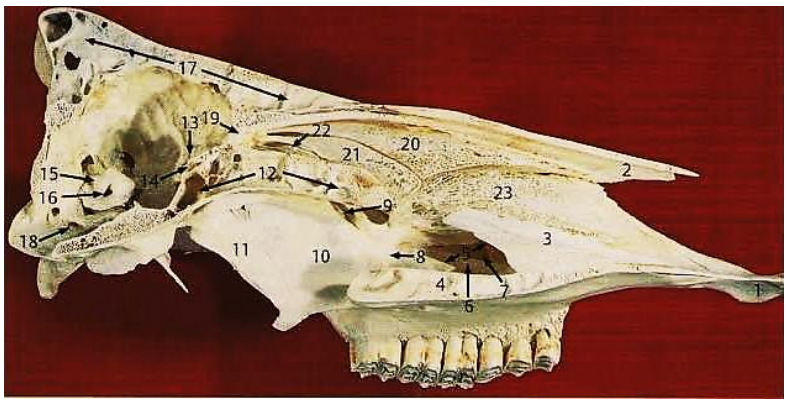


Figure 2.35: Bovine skull, medial view.
1, Premaxilla, 2, Nasal, 3, Vomer, 4,5, Palatine sinus, 6, Infraorbital canal, 7, Maxillary sinus, 8, Nasopharyngeal meatus, 9, Sphenopalatine foramen, 10, Palatine, 11, Pterygoid, 12, Sphenoidal sinus, 13, Orbitosphenoidal crest, 14, chiasma sulcus, 15, Petrous temporal, 16, Internal auditory meatus, 17, Frontal septum/sinus, 18, Hypoglossal foramen, 19, Ethmoid, 20, Dorsal turbinate, 21, Ventral turbinate, 22, Ethmoturbinate.

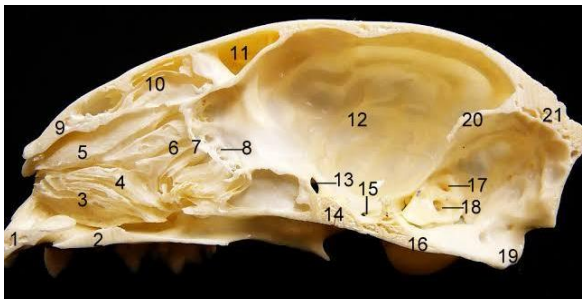


Figure 2.36: Feline skull, medial view.
1, Premaxilla, 2, Palatine process of maxilla, 3, 4, ventral turbinate, 5, Dorsal turbinate, 6, Etmoturbinate, 7, Perpendicular plate, 8, Cribiform plate, 9, Nasal bone, 10, Nasal sinus, 11, Frontal sinus, 12, Cranial cavity, 13, Optic foramen, 14, Presphenoid, 15, Oval foramen, 16, Basisphenoid, 17, Petrous temporal, 18, internal auditory meatus, 19, Occipital condyle, 20, Cerebella/tentorial crest, 21, Occipital.

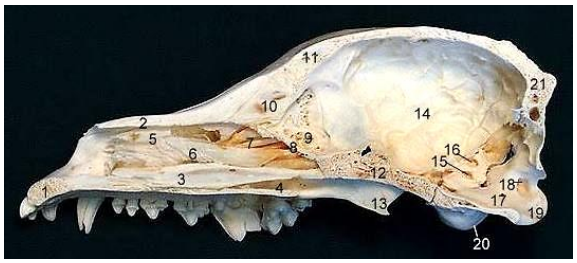


Figure 2.37: Canine skull, medial view.
1, Premaxilla, 2, Nasal, 3, Vomer, 4, Palatine sinus, 5, Dorsal turbinate, 6, Ventral turbinate, 7, Ethmoturbinate, 8, Perpendicular plate, 9, Cribiform plate, 10, Frontal sinus, 11, frontal, 12, Sphenoid, 13, Pterygoid, 14, Cranial cavity, 15, internal auditory meatus, 16, Petrous temporal, 17, basilar occipital, 18, Hypoglossal foramen, 19, Occipital condyle.

ACTIVITY:

Having studied the cranial and facial bones of the skull, list the bones that form the boundaries of the **cranial cavity.** Also label the numbered parts of the medial view of the skull of the _____ species.

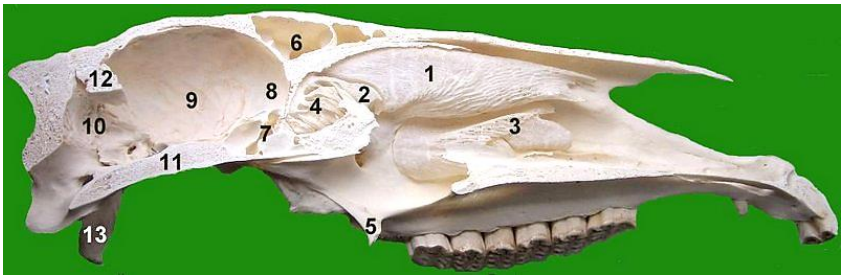
Boundaries of the cranial cavity

Dorsally _____

Ventrally _____

Laterally _____

Cranially _____



1 _____
2 _____
3 _____
4 _____
6 _____
7 _____
8 _____
10 _____
12 _____

CRANIAL VIEW

All bones seen from the cranial view have been discussed, however, the purpose of viewing the skull cranially is to describe the bony boundaries of the ***nasal cavity***.

Nasal cavity

The nasal cavity is a longitudinal passage that extends through the upper part of the face. It is divided into right and left halves by a median septum nasi.

The lateral walls are formed by the maxilla, premaxilla, and the perpendicular part of the palate bones. Attached to them are the turbinal bones, which subdivide each nasal fossa into three meatuses. This wall is crossed obliquely by the canal and groove for the naso-lacrimal duct, and its caudal part is perforated by the spheno-palatine foramen.

The dorsal wall or roof is formed by the frontal and nasal bones. It presents a median elevation, the nasal crest.

The ventral wall or floor is formed by the palatine processes of the premaxilla and maxilla, and the horizontal parts of the palatine bones. It is wider but considerably shorter than the roof. The cranial part presents a median groove for the cartilaginous septum.

The nasal septum is incomplete in the macerated skull. It is formed by the perpendicular plate of the ethmoid behind, and the vomer below. In the fresh state it is completed by a plate of cartilage.

The dorsal meatus is a narrow passage between the roof and the dorsal turbinate bone. It ends at the cribriform plate of the ethmoid.

The middle meatus is the space between the two turbinate bones. In its caudal part is the very narrow opening into the maxillary sinus.

The ventral meatus is the channel along the floor which is overhung by the ventral turbinate bone. It is much the largest and is the direct path between the anterior and posterior nares. The external aperture is bounded by the nasal bones and the premaxillae. The caudal extremity or fundus is separated from the cranial cavity by the cribriform plate of the ethmoid, and is largely occupied by the lateral masses of that bone.

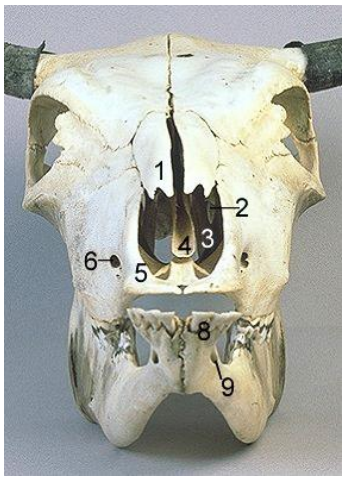


Figure 2.38: Bovine skull, cranial view.
1, Nasal, 2, Turbinate, 3, Nasal cavity, 4, Vomer, 5, Premaxilla, 6, Infraorbital foramen, 8, Lower incissors, 9, Mental foramen.

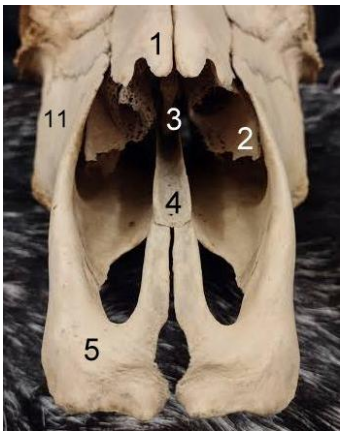


Figure 2.39: Equine skull, cranial view



Figure 2.40: Canine skull, cranial view

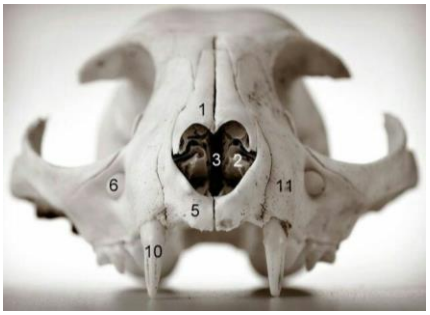


Figure 2.41: Feline skull, cranial view

1, Nasal, 2, Turbinate, 3, Nasal cavity, 4, Vomer, 5, Premaxilla, 6, Infraorbital foramen, 7, Upper incissors, 8, Lower incissors, 9, Mental foramen, 10, Canine, 11. Maxilla.

Porcine skull, cranial view

ACTIVITY:

Sketch and label the cranial view of the porcine skull.

Paranasal sinuses

Connected directly or indirectly with the nasal cavity are four pairs of air-sinuses namely: *maxillary*, *frontal*, *spheno-palatine*, and *ethmoidal sinuses.*

The maxillary sinus is the largest. Its external wall is formed by the maxilla, the lacrimal, and the malar. It is bounded internally by the maxilla, the ventral turbinate, and the lateral mass of the ethmoid bone. It extends backward to a transverse plane in front of the root of the supraorbital process, and its anterior limit is indicated approximately by a line drawn from the anterior end of the facial crest to the infraorbital foramen.

The frontal sinus consists of frontal and turbinal parts. The frontal part is bounded chiefly by the two plates of the frontal bone, but its floor is formed in part by the lateral mass of the ethmoid. It extends forward to a plano through the anterior margins of the orbits, backward to one through the temporal condyles, and outward into the root of the supraorbital process. It is separated from the sinus of the opposite side by a complete septum. It is partially subdivided by a number of bony plates. The turbinal part is situated in the caudal part of the dorsal turbinate bone, roofed in by the nasal and lacrimal bones. It extends forward to a transverse plane about half-way between the cranial margin of the orbit and the end of the facial crest.

The spheno-palatine sinus consists of two parts which communicate under the lateral mass of the ethmoid. The sphenoidal (caudal) part is excavated in the body of the pre-sphenoid. The palatine (rostral) part is between the two plates of the perpendicular part of the palate bone, under the lateral mass of the ethmoid; it communicates freely with the maxillary sinus.

The ethmoidal sinus is the cavity of the largest ethmo-turbinal. It communicates with the maxillary sinus.

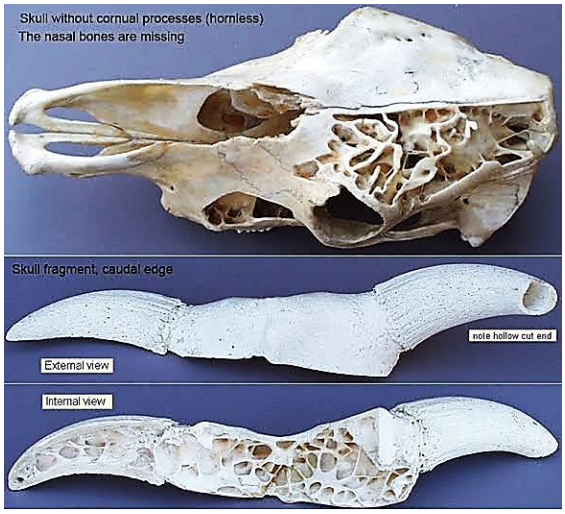


Figure 2.42: Bovine skull (hornless and horn) dorsal view, showing frontal sinus.

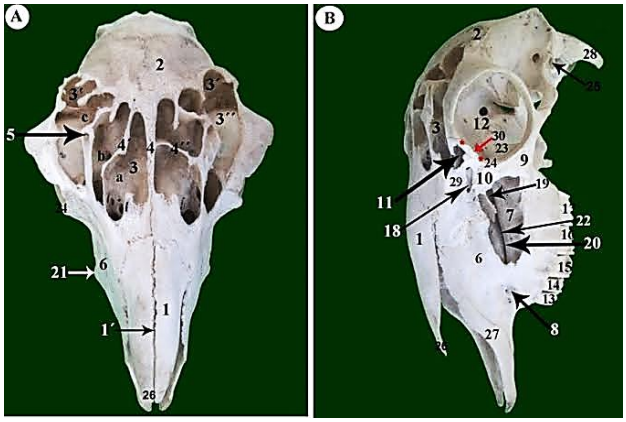
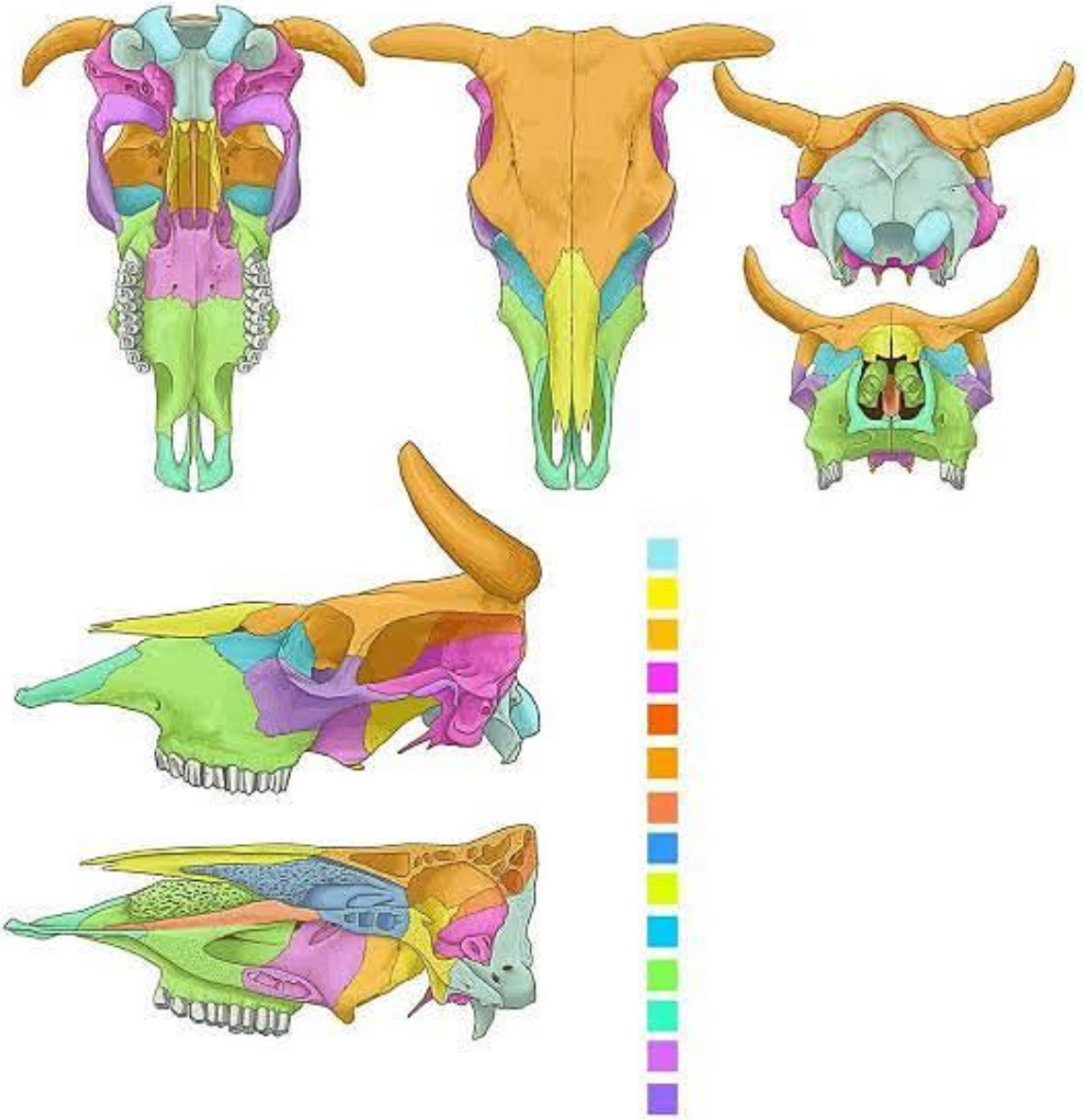


Figure 2.43: Ovine skull, dorsal and lateral views showing paranasal sinus.
3, 3', 3'', Frontal sinus, 5, Supraorbital foramen, 7, Maxillary sinus, 8, Infraorbital foramen.

SUMMARY ACTIVITY:

Having studied the skull, use the schematic diagrams to identify the bones of the Bovine skull stating below each diagram the views.



Chapter 3: **VERTEBRAL COLUMN**

The vertebral column consists of a chain of median, unpaired, irregular bones which extends from the skull to the end of the tail.

The column is subdivided for description into five regions, which are named according to the part of the body in which they are placed. Thus the vertebrae are designated as cervical, thoracic, lumbar, sacral, and coccygeal or caudal. The number of vertebrae in a given species is fairly constant in each region except the last.

INSTRUCTION:

Identify the five regions of the vertebral column on the articulated skeleton of any domestic animal by locating their positions as described below:

Cervical vertebrae – The first seven vertebrae caudal to the skull (Occipital bone). They are usually quadrangular, massive, and longer than the vertebrae of other regions.
The first (atlas) and second (axis) vertebrae are atypical or highly modified.

Thoracic vertebrae – These are the vertebrae that anchor the ribs dorsally. There are placed after the seventh cervical and are usually 13-18 in number depending on the species.

Lumbar vertebrae – These are vertebral bones placed dorsal to the abdominal region. They are usually 6-7 in number starting from the first lumber vertebra without a rib to the last cranial to the fused sacrum.

Sacral vertebrae - The sacrum is formed by the fusion of 3-5 vertebrae, hence is conveniently described as a single bone. It forms the dorsum of the bony pelvis.

Coccygeal vertebrae – These are placed at the caudal region of the animal forming skeletal part of the tail. They vary considerably in number in same and different species.

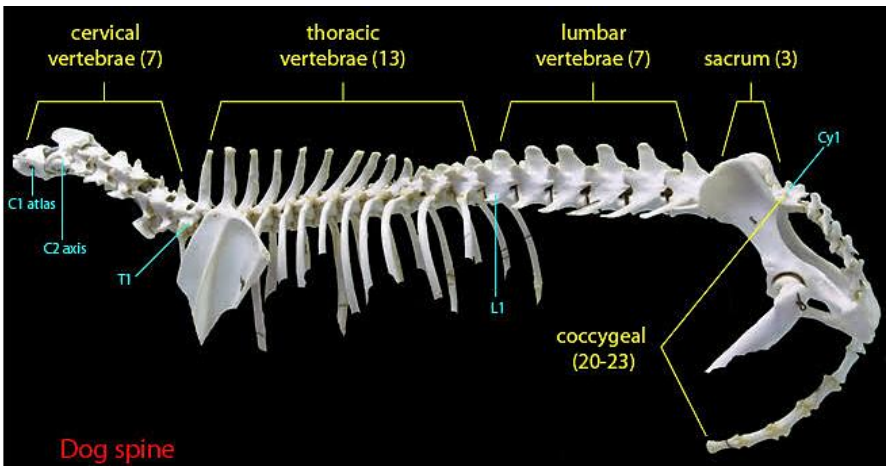


Figure 3.0: Vertebral column of the Dog showing parts of the scapula, ribs, pelvis and femur.

The number of vertebrae in each region in different species is presented in the table below.

Bone	Equine	Bovine	Ovine	Caprine	Porcine	Canine	Feline
Cervical	7	7	7	7	7	7	7
Thoracic	18	13	13	13	14 – 15	13	13
Lumbar	6	6	6 – 7	6 – 7	6 – 7	7	7
Sacral	5	5	4	4	4	3	3
Coccygeal	15 – 21	18 – 20	16 – 18	16 – 18	20 – 23	20 – 23	20 – 23

The vertebral column can also be structurally divided into two namely:

Atypical – Atlas, Axis and Last few caudal vertebrae
Typical – 3rd – 7th Cervical, Thoracic, Lumbar, Sacral and first 4-5 caudal vertebrae.

Each vertebral region has special distinguishing characteristics and individual vertebrae also have characters which are more or less clearly recognizable.

All typical vertebrae have a common plan of structure with parts which should be identified as follows:

Body (Corpus, centrum) – The cylindrical mass on which the other parts of the vertebrae are constructed. The cranial and caudal extremities of the body are attached to the adjacent vertebrae by intervertebral fibro-cartilages, and are usually convex and concave respectively. The dorsal surface is flattened forming the ventral surface of the vertebral canal, while the ventral aspect is somewhat rounded. In the thoracic region the body presents two pairs of demi facets at the extremities for articulation with the heads of two pairs of ribs.

Arch – This is constructed on the dorsal aspect of the body. It consists originally of two lateral halves, each of which is considered to consist of *pedicle* and *lamina*.
The pedicles form the lateral parts of the arch, and are cut into in front and behind by the vertebral notches. The notches of two adjacent vertebra' form intervertebral foramina for the passage of the spinal nerves and vessels; in some vertebrae, however, these are complete foramina instead of notches.
The laminae are plates which complete the arch dorsally, uniting with each other medially at the root of the spinous process.

N.B: The body and the arch form a bony ring which encloses the vertebral foramen. The series of vertebral rings, together with the ligaments which unite them, enclose the vertebral canal, which contains the spinal cord and its coverings and vessels.

Processes

The *articular processes* (two cranial and two caudal) project from the border of the arch on either sides. They present joint surfaces adapted to those of adjacent vertebrae, and the remaining surface is roughened for muscular and ligamentous attachment.

The *spinous process* is single, and projects dorsally from the middle of the arch. It varies greatly in form, size, and direction in different vertebrae. It furnishes attachment to muscles and ligaments.

The *transverse processes* are two in number and project laterally from the side of the arch, or from the junction of the arch and body. In the thoracic region each has a facet for articulation with the tubercle of a rib.

Some vertebrae have also a ventral process.

The *Mammillary processes* are found between the transverse and cranial articular processes or on the cranial articular processes of some thoracic and lumbar vertebrae

The *Accessory processes* are situated between the transverse and caudal articular processes of some lumbar vertebrae in some species.

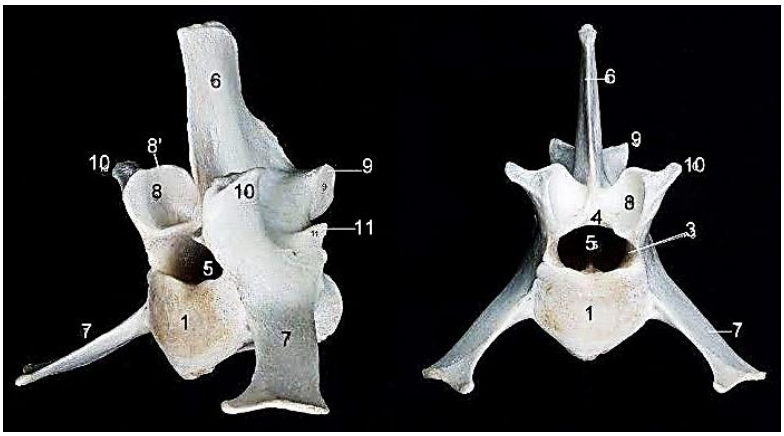


Figure 3.1: Typical Vertebrae.
1, Body, 3, Pedicle, 4, Lamina, 5, Vertebral foramen, 6, Spinous process, 7, Transverse process, 8, Cranial articular process with facet, 9, Caudal articular process, 10, Mammillary process, 11, Accessory process.

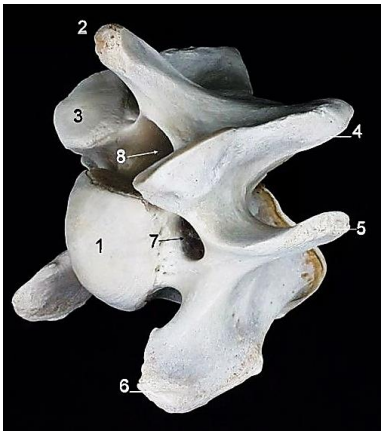


Figure 3.2: Typical vertebrae.
1, Body, 2, Spinous process, 3, Cranial articular process with facet, 4, Caudal articular process, 5, Transverse process, 6, Ventral process, 7, Transverse foramen, 8, Vertebral foramen.

INSTRUCTION:

Identify the bones in each region of the vertebral column of the **ruminant species (Ox, Goat and sheep)** from the non-articulated bones by following the descriptions below.

Cervical vertebrae

Atlas:

This is atypical in form and structure. The body and spinous process are absent. It has the form of a strong ring from which the wings, project laterally. The ring which encloses the vertebral foramen, consists of two lateral masses connected by dorsal and ventral arches.

The lateral masses present two deep oval cranial articular cavities. The caudal articular surfaces are somewhat saddle-shaped and do not conform in shape to the corresponding surfaces of the axis.

The dorsal arch presents a median dorsal tubercle. It is perforated on either side near its cranial margin by the intervertebral foramen.

The ventral surface of the ventral arch bears the ventral tubercle while its dorsal face presents a concave articular surface – the Fovea dentis, on which the dens or odontoid process of the axis rests.

The wings are modified transverse processes. They are extensive curved plates which project outward from the lateral masses. On the ventral aspect is a cavity, the fossa atlantis; in this there is the alar foramen which opens into the vertebral canal and can also be seen dorsally. The alar foramen is connected with the intervertebral foramen by a short groove.

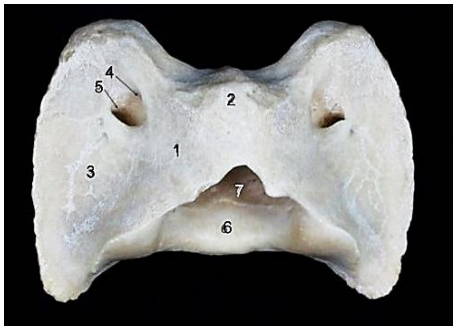


Figure 3.3: Ovine Atlas vertebra (dorsal view).
1, Arch, 2, Dorsal tubercle, 3, Wing, 4, Alar foramen, 5, Lateral vertebral foramen, 6, Caudal articular facet, 7, Fovea dentis.

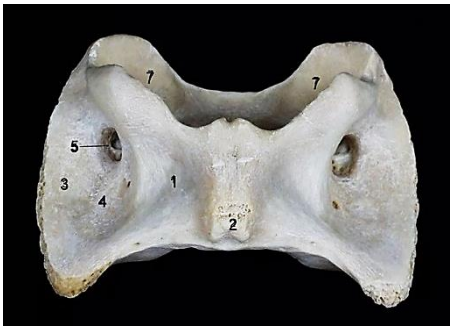


Figure 3.4: Ovine Atlas vertebra (ventral view).
1, Ventral arch, 2, Ventral tubercle, 3, Wing, 4, Atlanta fossa, 5, Alar foramen, 7, Cranial articular facet.

Axis:

This is characterized by the presence of the odontoid process, which projects from the cranial part of the body. The odontoid process or Dens has a convex articular surface ventrally for articulation with the ventral arch of the atlas, and two rough depressions for the attachment of the odontoid ligament dorsally. Flanking this on either side are the modified cranial articular processes, which have saddle-shaped articular surfaces.

The caudal surface of the body is concave. The caudal articular processes are typical. The transverse processes are small, single, and project backward. The transverse foramen is present craniolaterally. The spinous process is large and projects forward.

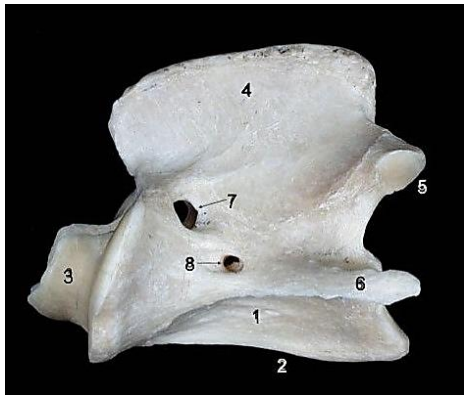


Figure 3.5: Ovine Axis (Lateral view)

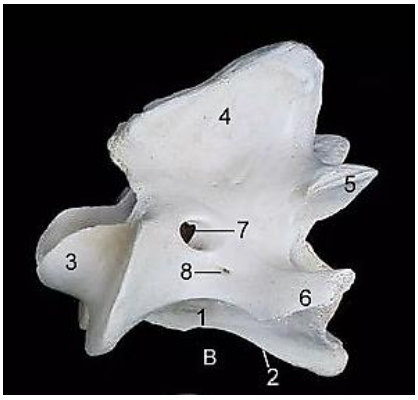


Figure 3.6: Bovine Axis (Lateral view)

1, Body, 2, Ventral crest, 3, Odontoid process, 4, Spinous process, 5, Caudal articular process, 6, Transverse process, 7, Lateral vertebral foramen, 8, Transverse foramen.

3rd -6th cervical vertebrae

- The bodies are long and each presents a median ventral spine or crest, which becomes more prominent as it is traced backward.
- The arches are large and notched cranially and caudally on either side thereby forming the intervertebral foramen with the preceding and succeeding vertebrae.
- The articular processes are large with extensive surfaces that are oval in outline. The cranial ones are directed upward while the caudal ones face downward.
- The transverse processes are short. Ventral processes extend downward from the body elongating along the series.
- The transverse foramen is between the body and the transverse process. The spinous process elongates along the series.

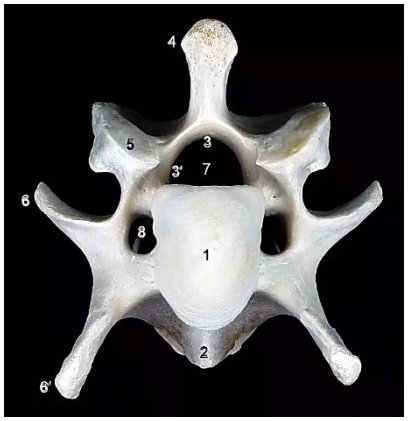


Figure 3.7: Bovine 5th cervical vertebra. 1, Body, 2, Ventral crest, 3, Lamina, 3', Pedicle, 4, Spinous process, 5, Cranial articular facet, 6, Transverse process, 6', Ventral process, 7, Vertebral foramen, 8, Transverse foramen.

7th cervical vertebra

The body is short and wide having a caudal coastal facet on the caudal surface of the body. Articular processes and surfaces are large and extensive respectively. Ventral process and transverse foramen are absent. The spinous process is the longest of the cervical series.

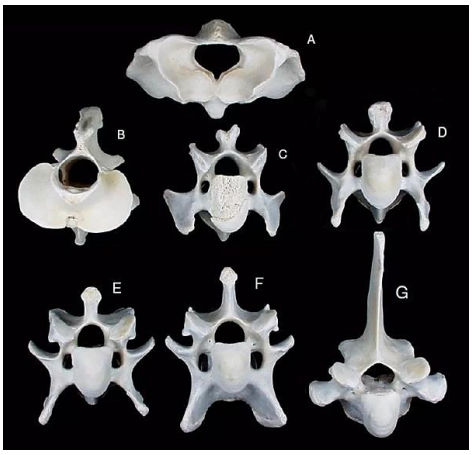


Figure 3.8: A-G Bovine first to seventh cervical vertebrae (cranial view)

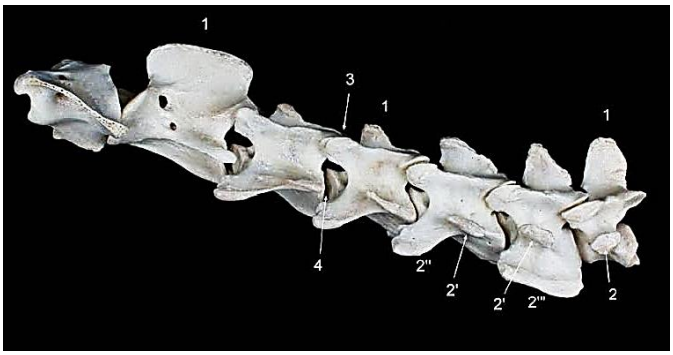


Figure 3.9: Ovine cervical vertebrae (lateral view)
1, Spinous process, 2, 2', Transverse process, 2'', 2''' Ventral process, 3, Articulation of the arches, 4, Articulation of the Bodies.

ACTIVITY:

Compare the features of bones of the cervical vertebrae in the bovine species using + for presence and – for absence.

Features	Atlas	Axis	3rd – 6th cervical	7th Cervical
Body				
Odontoid process				
Atlanta fossa				
Spinous process				
Transverse process				
Dorsal tubercle				
Ventral process				
Vertebral foramen				
Transverse foramen				
Alar foramen				
Lat. vertebral foramen				
Caudal coastal facet				
Fovea dentis				

Comparative anatomy:

Equine (Horse):

The Atlanta fossa of the Atlas has an additional foramen; the transverse foramen.

The Axis is the longest of the vertebrae, its spinous process is very large and strong. Its free border is rough, thickens caudally, and is continued to the articular processes by two ridges.

The articular processes are large, oval in outline and slightly concave; the cranial ones are directed upward and inward, the caudal ones downward and outward.

The transverse processes of the 3rd to 6th cervical vertebrae are large and plate-like. Each arises by two roots, one from the arch and one from the body; between these is the transverse foramen. The process divides externally into cranial and caudal branches, which are thickened and rough for muscular attachment.

The spinous process is represented by a crest which widens behind and is connected by ridges with the caudal articular processes.

The transverse processes of the sixth cervical vertebra have three branches.

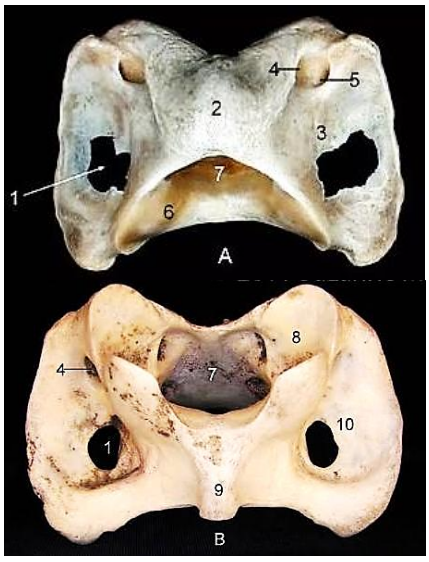


Figure 3.10: Equine Atlas, A-Dorsal and B-Ventral views.
1, Transverse foramen, 2, Dorsal tubercle, 3, Wing, 4, Alar foramen, 5, Lateral vertebral foramen, 6, Caudal articular surface, 7, Fovea dentis, 8, Cranial articular surface, 9, Ventral tubercle, 10, Atlanta fossa.

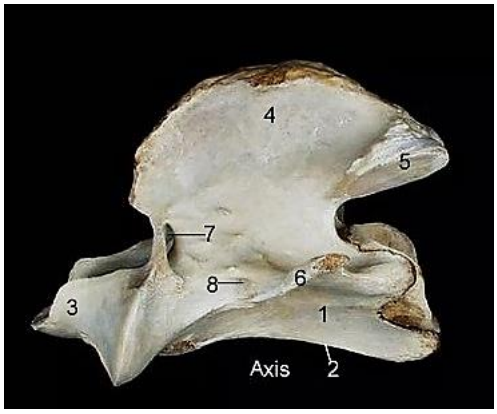


Figure 3.11: Equine axis (Lateral view).



Figure 3.12: Equine Cervical vertebrae (Lateral view).
1, Body, 2, Ventral crest, 3, Odontoid process, 4, Spinous process, 5, Caudal articular process with facet, 6, Transverse process, 7, Lateral vertebral foramen, 8, Transverse foramen.

Porcine (Pig):

Atlas bears a large tuberosity on the dorsal arch, the ventral tubercle is long and projects back under the axis. Its transverse foramen is not visible dorsally.

Axis has a large spinous process directed upward and backward, its odontoid process is a thick cylindrical rod and has a very small transverse process.

The cervical vertebrae are generally short and wide.

Ventral crest is absent.



Figure 3.13: Porcine Axis, A-Cranial, B-Lateral, C-Caudal views

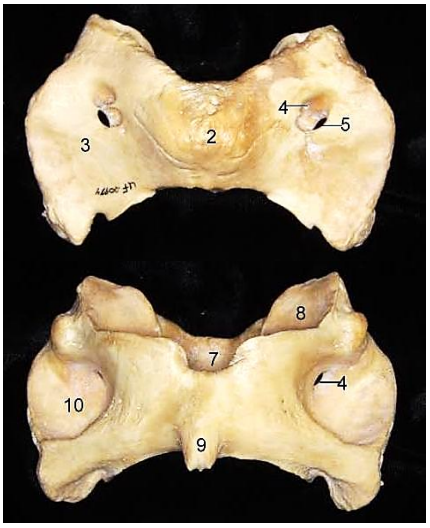




Figure 3.15: Porcine cervical vertebrae. (Lateral view)

Figure 3.14: Porcine Atlas, Dorsal and ventral views.
2, Dorsal tubercle, 3, Wing, 4, Alar foramen, 5, Lateral vertebral foramen, 7, Fovea dentis, 8, Cranial articular surface, 9, Ventral tubercle, 10, Atlanta fossa.

Canine (Dog):

The ventral arch of the atlas is narrow and bears a small tubercle caudally, the wings are wide, horizontal with an alar notch (instead of alar foramen) at the cranial boarder and transverse foramen.

Odontoid process of Axis is relatively long and inclined upward; transverse processes are single, pointed and perforated by a large transverse foramen; spinous process is long and prolongs forward.

The cervical vertebrae are relatively longer than in the ox and pig. Only the 6th has the ventral process.



Figure 3.16: Canine Atlas, Dorsal and ventral views.
1, Transverse foramen, 2, Dorsal tubercle, 3, Wing, 4, Alar foramen, 5, Lateral vertebral foramen, 6, Caudal articular surface, 7, Fovea dentis, 8, Cranial articular surface, 9, Ventral tubercle, 10, Atlanta fossa.

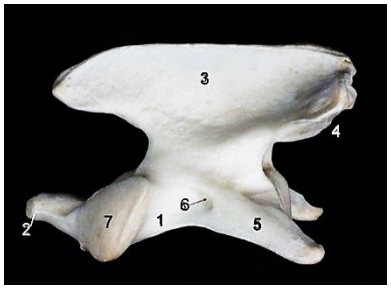


Figure 3.17: Equine Axis (Lateral view).
1, Body, 2, Odontoid process, 3, Spinous process, 4, Caudal articular process with facet, 5, Transverse process, 6, Transverse foramen.



Figure 3.18: Canine cervical vertebrae (lateral view)
1, Spinous process, 2, 2', Transverse process, 2'', 2''' Ventral process, 3, Articulation of the arches.

Feline (Cat):
Similar to the Dog.

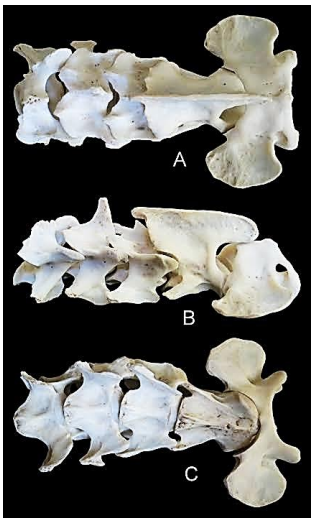


Figure 3.19: Feline first five cervical vertebrae.
(A-Dorsal, B-Lateral and C-Ventral views)

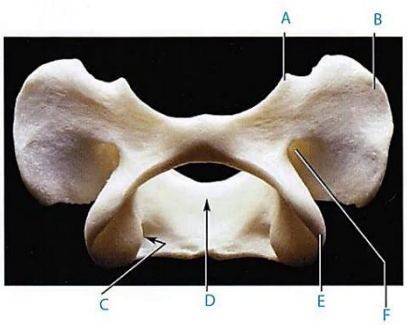


Figure 3.20: Feline Atlas (Ventral view)
A-Caudal articular facet, B-Wing, C-Lateral vertebral foramen, D-Fovea dentis, E-Cranial articular facet, F-Transverse foramen.

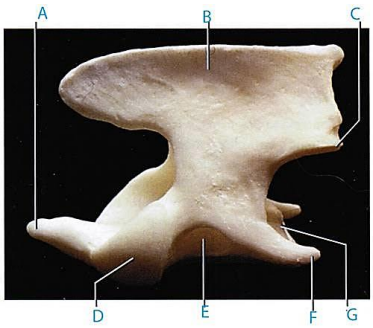


Figure 3.21: Feline Axis (Lateral view). A-Odontoid process, B-Spinous process, C-Caudal articular facet, D-Cranial articular facet, E-Body, F-Transverse process, G-Caudal surface of body.

ACTIVITY:
Sketch and label the cranial and caudal views of the equine 7th cervical vertebra. Also compare the features of the cervical vertebrae in these species using + for presence and – for absence.

7th Cervical (cranial view)	7th Cervical (caudal view)

Bone and Features	Ox	Horse	Pig	Dog	Cat
ATLAS					
Alar notch					
Transverse foramen					
Intervertebral foramen					
Atlanta fossa					
Dorsal tubercle					
AXIS					
Forward spinous process					
Backward spinous process					
Upward odontoid process					
Long odontoid process					
Cylindrical odontoid process					
3RD – 6TH CERVICAL					
Ventral process					
Divided transverse process					
Ventral crest					
Transverse foramen					
7TH CERVICAL					
Caudal coastal facet					
Transverse foramen					
Long spinous process					

Thoracic vertebrae

The bodies are short and constricted in the middle. The cranial and caudal ends have convex and concave surfaces respectively. They bear cranial and caudal costal facets, which with those of adjacent vertebrae, form sockets for the heads of the ribs.
The arch is perforated in the caudal part by a foramen in addition to the usual notches.

The articular processes are small. The cranial pair is in fact represented only by two oval facets on the cranial part of the laminae which face almost directly upward. The caudal pair spring from the base of the spinous process; their facets face almost directly downward.

The transverse processes are short, thick, and tuberous at the free end; each has a facet for articulation with the tuberosity of the rib which has the same serial number. The transverse process bears the rounded mammillary process except at the caudal end of the series.

The spinous process is large, narrow, and slopes upward and backward.

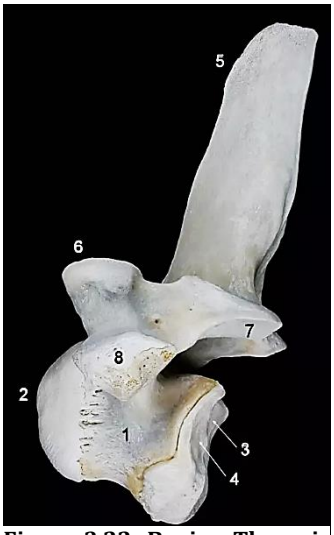


Figure 3.22: Bovine Thoracic vertebra (Lateral view).
1, Body, 2, Cranial surface, 3, Caudal surface, 4, Caudal coastal facet, 5, Spinous process, 6, Cranial articular process, 7, Caudal articular process, 8, Transverse process.

The second and third spinous processes are usually the most prominent caudal to which there is gradual diminution in height; the last is vertical and lumbar in character.

The last thoracic vertebra is distinguished by the absence of the caudal pair of costal facets, and the confluence of the cranial pair with those on the transverse processes.

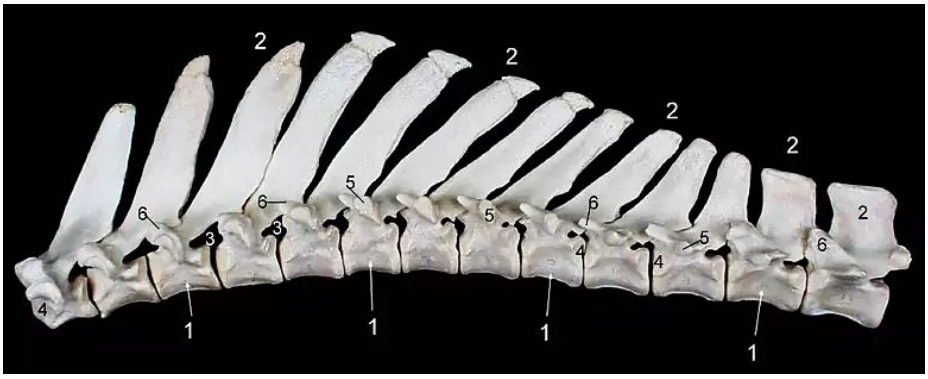


Figure 3.23: Ovine thoracic vertebrae (Lateral view). 1, Body, 2, Spinous process, 3, Intervertebral foramen, 4, Coastal facets, 5, Transverse process, 6, Mammillary process.

Comparative anatomy:

Equine (Horse):

Bodies and transverse processes are similar to that of the Ox.

The arches are small. Their caudal notches are relatively large and are often converted into foramina. Mammillary process seen throughout the series.

The spinous processes are larger than the Ox and also slopes upward and backward. That of the first thoracic is short, curves backward and tapers to a point.



Figure 3.24: 11th, 12th and 13th Equine thoracic vertebra (Lateral view).
1, Intervertebral foramen, 2, Lateral vertebral foramen, 3, body, 4, Ventral crest, 5, Transverse foramen, 6, Spinous process, 7, Mammillary process, 8, Caudal coastal facet, 9, Cranial coastal facet.



Figure 3.25: Complete Equine Thoracic vertebrae (Lateral view).

Porcine (Pig)

Bodies are relatively long, constricted in the middle, and without ventral crests. The arch is perforated by a foramen on either side, and in most of the series there is also a foramen in the caudal part of the root of the transverse process which communicates with the former or with the caudal intervertebral foramen. Sometimes there is a foramen in the cranial part of the process also. There are mammillary processes except on the first two; in the caudal five or six vertebrae they project from the anterior articular processes. The facet for the tubercle of the rib is absent or fused with that for the head in the last three or four. Accessory processes are present in this last three to four thoracic vertebrae. The last transverse process is lumbar in character and plate-like. The first spinous process is broad, very high, and inclined a little forward. The others diminish very gradually in length to the tenth, beyond which they are about equal.



Figure 3.26: Porcine thoracic vertebrae (Lateral view)

Canine (Dog):

The bodies are wide and compressed dorso-ventrally, especially at each end of the region. The caudal facets for the heads of the ribs are absent on the last three or four. The transverse processes resemble those of the horse. They bear mammillary processes. The facets for the tubercles of the ribs are large and concave in the cranial part of the series, and become smaller and slightly convex further back. The last three have accessory processes also. The first three or four spinous processes are about equal in length.



Figure 3.27: Canine Thoracic vertebrae (Lateral view)

Feline (Cat):

The spinous processes of the first nine appear the same in size. Mammillary process can also be seen except on the last three thoracic.

ACTIVITY:

Compare the features of the thoracic vertebrae in these species using + for presence and – for absence.

Bone and Features	Ox	Horse	Pig	Dog	Cat
2ND – 5TH THORACIC					
Spinous process					
Transverse process					
Transverse foramen					
Lateral vertebral foramen					
Mammillary process					
Cranial articular process					
Caudal articular process					
Accessory process					
Coastal facet					
LAST 3 THORACIC					
Spinous process					
Transverse process					
Transverse foramen					
Lateral vertebral foramen					
Mammillary process					
Accessory process					
Coastal facet					

Lumbar Vertebrae

The lumbar vertebrae are usually characterized by the size and form of their transverse processes. They are quite long with bodies constricted in the middle, expanded at both end, and bear rudimentary ventral crests. The fourth and fifth are usually the longest. The intervertebral foramina are often double in the cranial part of the series, and are very large further back. The transverse processes all curve forward and separated by considerable intervals. The spinous processes are relatively low and wide, the last being the smallest; their summits are moderately thickened.

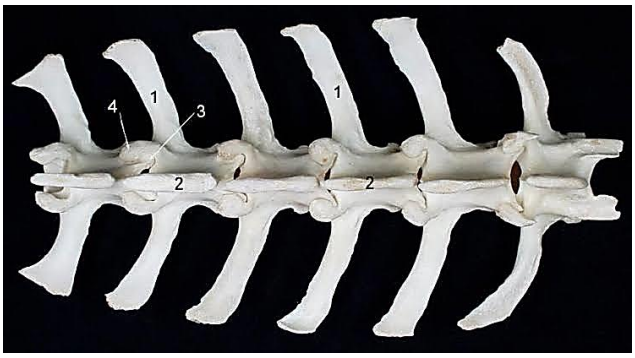


Figure 3.28: Ovine Lumber vertebrae (Dorsal view).
1, Transverse process, 2, Spinous process, 3, Caudal articular process, 4, Cranial articular process.



Figure 3.29: Bovine Lumber vertebrae (Dorsal view).

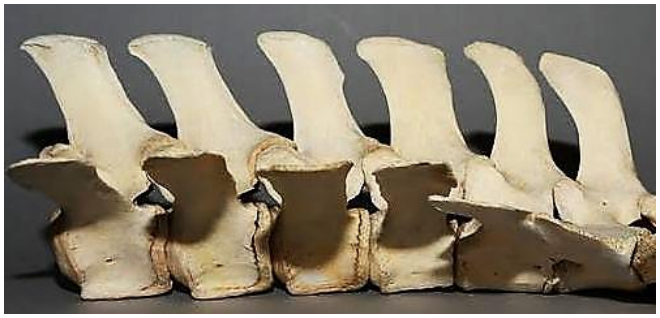


Figure 3.30: Bovine lumber vertebrae (Lateral view)

Comparative Anatomy:

Equine (Horse):
The bodies of the first three are triangular on cross-section, and present a distinct ventral crest. The cranial articular processes are fused with the mammillary processes and present dorsally concave surfaces for articulation with the caudal pair of the preceding vertebra. The

caudal articular processes project distinctly from the arch at the base of the spinous process, and have ventrally convex articular surfaces, which fit into the grooved surfaces of the cranial pair of the next vertebra.

The transverse processes are large plates, flattened dorso-ventrally, which project outward and usually curve slightly downward; their length increases to the third and fourth, and then diminishes to the last, which is the shortest. Those of the fifth have an oval concave facet on the inner part of the caudal border for articulation with the sixth process; which has a corresponding convex facet on the cranial border, and a larger concave surface on the caudal border for articulation with the wing of the sacrum.



Figure 3.31: Equine lumber vertebrae with some parts of the sacrum.

The spinous processes resemble those of the last two thoracic vertebrae. They are usually about equal in height, but minor differences are common, and the width diminishes in the last three.

Porcine (Pig):

The lumbar vertebrae are six or seven in number. The bodies are longer than in the thoracic region and bear a ventral crest. They become wider and flatter in the caudal part of the series. The arches are deeply notched, and are separated by an increasing space dorsally. The mammillary processes project outward and backward. The transverse processes are bent downward and incline a little forward. They form no articulation with each other or with the sacrum. The spines are broad and incline forward, with the exception of the last, which is narrow and vertical.



Figure 3.32: Porcine Lumber vertebrae (Dorsal view)



Figure 3.33: Porcine Lumber vertebrae (Lateral view)

Canine (Dog):

The bodies of the lumbar vertebrae are flattened dorso-ventrally, and increase in width from first to last. The transverse processes are plate-like and are directed forward and downward. They form no joints with each other or with the sacrum. Their extremities are enlarged, with the exception of the last. Accessory processes project backward over the caudal notches of the

first five. The cranial articular processes are large, compressed laterally, and bear mammillary processes. The height of the spinous processes diminishes behind the fourth.

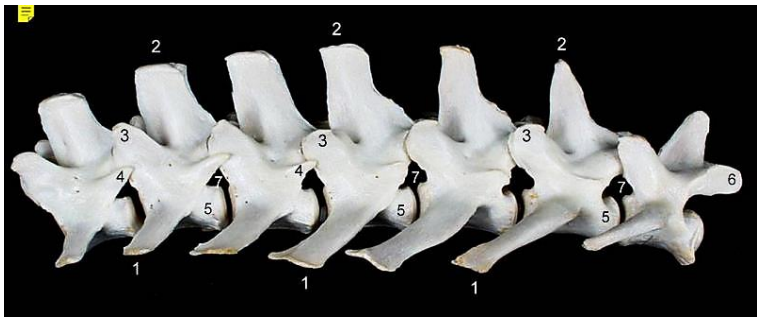


Figure 3.34: Canine Lumber vertebrae (Lateral view)
1, Transverse process, 2, Spinous process, 3, Cranial articular process, 4, Accessory process, 5, Body, 6, Caudal articular process, 7, Intervertebral foramen.

ACTIVITY:
Sketch the lateral view of the feline lumbar vertebrae and highlight its differences from that of the bovine, equine, porcine and canine.

Feline lumbar vertebrae (Lateral view)	

Sacral vertebrae or Sacrum

The sacrum is formed by the fusion of five vertebrae and is therefore described as a single bone. It is triangular in form presenting two surfaces, two borders, a base, and an apex.

The dorsal surface presents centrally the median sacral crest (formed from fusion of the sacral spines). On either side of the median sacral crest is the lateral sacral crest (formed by the fusion of the articular processes) which crosses the dorsal sacral foramina.

The ventral or pelvic surface is marked by four more or less distinct transverse lines which indicate the demarcation of the bodies of the vertebra. At the ends of these lines are the ventral sacral foramina which are larger than the dorsal series and diminish in size from first to last. The dorsal and ventral foramina communicate with the sacral canal and are together equivalent to the usual intervertebral foramina.
The lateral borders are rough, thick in front and thin behind.

The base is directed forward, and is relatively very wide. It presents centrally the body of the first sacral segment. The ventral margin projects slightly, forming the promontory. Above the body is the entrance to the sacral canal, flanked by a pair of articular processes, which articulate with the last lumbar vertebra. The lateral parts of the base consists of the wings or alae which result from the fusion of the first with part of the second transverse process.
Dorsolaterally, the wings are quadrangular, short and presents an elongated rough triangular auricular surface for articulation with the ilium.

The apex is the caudal aspect of the last sacral vertebra and is quite small. It presents the elliptical flattened surface of the body, above which is the triangular caudal opening of the sacral canal, surmounted by the last sacral spine.

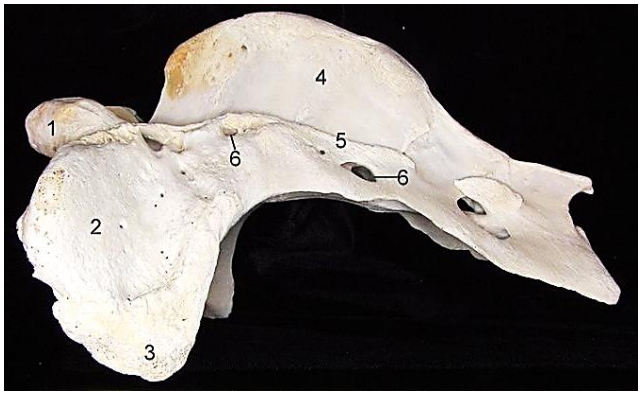


Figure 3.35: Bovine sacrum, lateral view.
1, Cranial articular process, 2, Wing of Sacrum, 3, Auricular surface, 4, Median sacral crest, 5, Lateral sacral crest, 6, Dorsal sacral foramina.



Figure 3.36: Bovine sacrum, ventral view.
2, Wing of sacrum, 7, Ventral sacral foramina.

Comparative Anatomy:

Equine (Horse):
The sacrum is shorter than in the Ox.
The dorsal surface presents centrally the five sacral spines, which are directed upward and backward, and have (with the exception of the first) tuberous summits which are sometimes bifid. On either side of the spines is a groove, in which are the four dorsal sacral foramina; the lateral sacral crest is absent.
Each wing has at its base a large, oval, slightly convex surface for articulation with the transverse process of the last lumbar. The auricular surface of the wing is an elongated oval area.

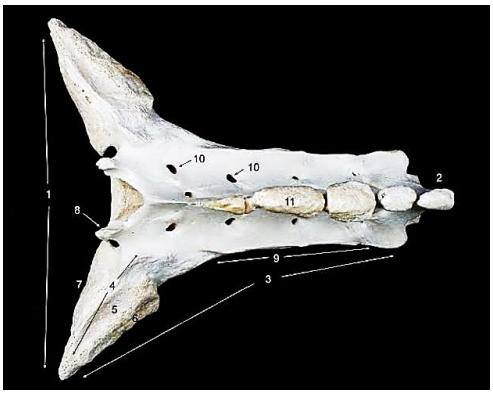


Figure 3.37: Equine sacrum, dorsal view.

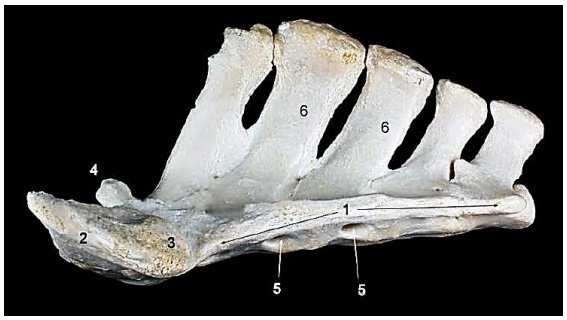


Figure 3.38: Equine sacrum, lateral view.

Porcine (Pig):
The sacrum consists usually of four vertebrae, which fuse later and less completely than in the other domesticated animals. Fusion is such that the spines are absent. The wings and pelvic surface resembles that of the ox, but is not so strongly curved, and the transverse lines are very distinct.

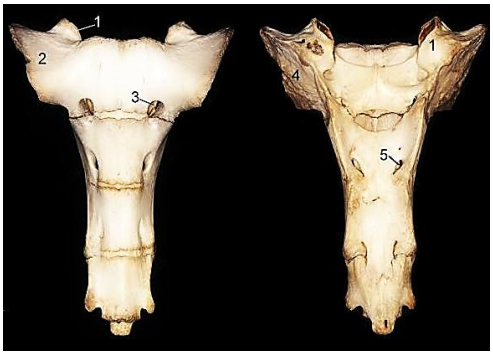


Figure 3.39: Porcine sacrum, ventral and dorsal views. 1, Cranial articular process, 2, Wing of sacrum, 3, Ventral sacral foramen, 4, Auricular surface, 5, Dorsal sacral foramen.

Canine (Dog):
The sacrum results from the early fusion of three vertebrae. It is short, wide and quadrangular. The spines are fused to form a median crest, which is notched, however, between the summits of the spines. On either side are two tubercles, vestiges of the fused articular processes. The pelvic surface is deeply concave and presents two pairs of foramina. The wings are prismatic and very high. Their lateral surfaces are

extensive, face almost directly outward, and bear an auricular surface on the lower part. The cranial surface of the body of the first vertebra is extensive, depressed in its middle, and bears a prominent lip below. The transverse processes of the last vertebra project backward and may articulate or fuse with those of the first coccygeal. The sacral canal is strongly compressed dorso-ventrally.

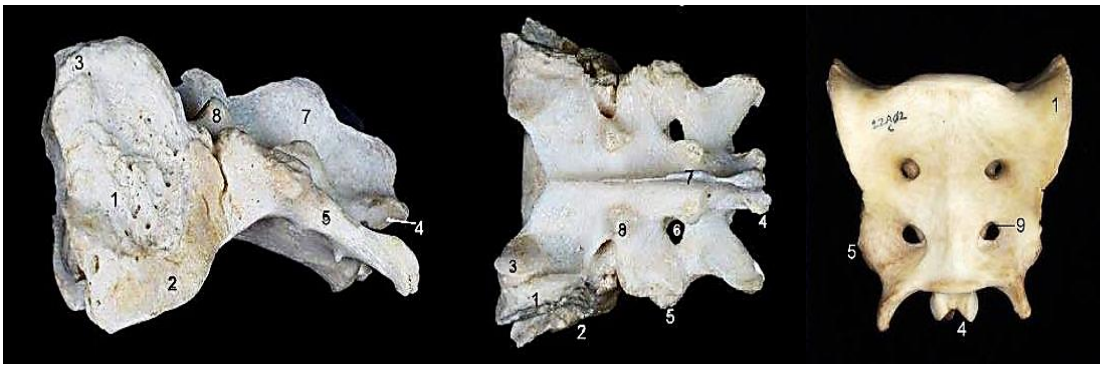


Figure 3.40: Canine sacrum, Lateral, Dorsal and Ventral views.
1, Wing of sacrum, 2, Auricular surface, 3, Cranial articular surface, 4, Caudal articular process, 5, Lateral surface, 6, Dorsal sacral foramen, 7, Medial sacral crest, 8, Lateral articular process, 9, Ventral sacral foramen.

Feline (Cat):
Similar in many ways to the Dog. However, the lateral surface appears concave.



Figure 3.41: Feline sacrum, Dorsal and Ventral views.

Coccygeal vertebrae

These vary considerably in number. From first to last they become reduced in size and with the exception of a few at the beginning of the series, consist of bodies only.
The first five or six coccygeal vertebrae have complete arches and spinous processes. The transverse processes are relatively large in the cranial part of the series, in which there are also cranial articular processes (which do not articulate), and a pair of ventral spines which form a hemal groove for the middle coccygeal artery.

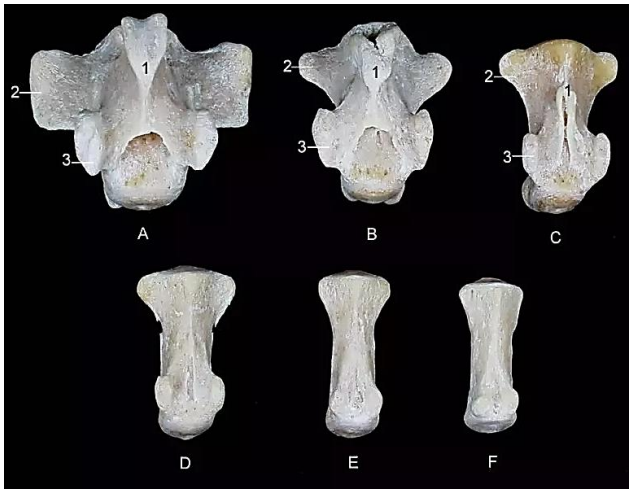


Figure 3.42: Different sections of Bovine coccygeal vertebrae (Dorsal views). A – 1st to 5th , B – 6th to 9th, C – 10th to 12th, D – 13th – 14th, E – 15th – 17th, F – 18th – 20th.
1, Spinous process, 2, Cranial articular process, 3, Caudal articular process.

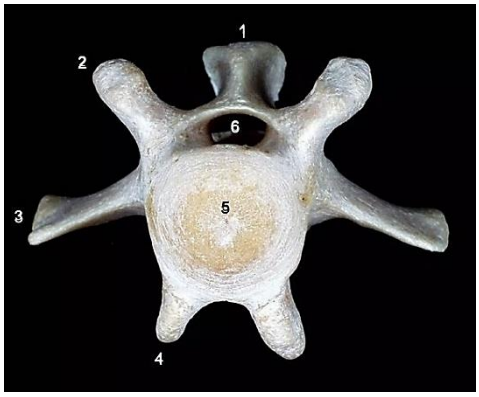


Figure 3.43: First Bovine coccygeal vertebra (caudal view).
1, Spinous process, 2, Cranial articular process, 3, Transverse process, 4, Hemal process, 5, Body, 6, vertebral foramen.

Comparative Anatomy:

Equine (Horse):
The first three have bodies which are somewhat flattened dorso-ventrally, constricted in the middle, and have at the ends slightly convex, elliptical, articular surfaces.
The ventral surface has a median groove for the coccygeal artery. The arch is small and triangular; it is formed of two fiat plates which are prolonged to form a short spinous process with a thickened and often double summit. The cranial notches are absent.
Functional articular processes are not present, but small rudiments of the cranial pair commonly occur. The transverse processes are relatively large plates which project horizontally outward. Further back, the arch becomes incomplete, open above, and soon disappears; the transverse processes gradually fade out, and the vertebrae are reduced to cylindrical rods of diminishing size. The last one has a pointed end.

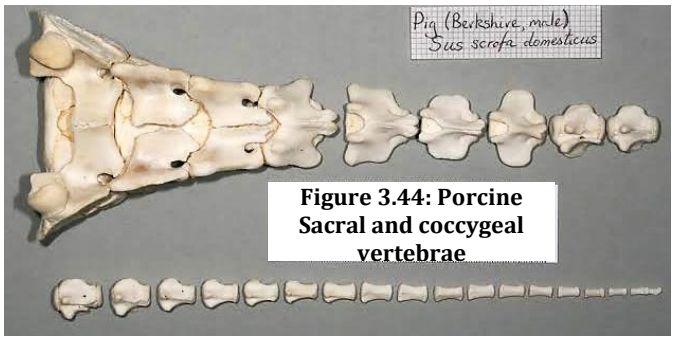


Figure 3.44: Porcine Sacral and coccygeal vertebrae

Porcine (Pig):
The coccygeal vertebrae are specially characterized by the presence of functional articular processes on the first four or five, beyond which these processes become non-articular and

smaller. The arches of the first five or six are complete. The transverse processes are broad and plate-like in the anterior part of the series and diminish very gradually.

Canine (Dog):
The coccygeal vertebrae are fully developed in the cranial part of the region. The arch is complete in the first six. The first three or four have well developed articular processes at each end. Behind this the caudal pair quickly disappears, and the cranial ones become non-articular and gradually reduced in size. The transverse processes of the first five or six are relatively large; behind this they quickly disappear. Haemal arches (or chevron bones) in the form of a V or Y occur ventrally at the intercentral junctions of the third, fourth, and fifth usually. They transmit the middle coccygeal artery, which passes between pairs of ventral tubercles further back.



Figure 3.45: Canine coccygeal vertebrae showing different sections.
A-Cranial, B-Middle, C-Caudal.

Feline (Cat):
Similar to the Dog.

ACTIVITY:

Compare the features in bones of the vertebral column using + for presence and – for absence.

Features	Cervical	Thoracic	Lumber	Sacral	Coccygeal
Body and arch					
Vertebral foramen					
Transverse foramen					
Lateral vertebral foramen					
Dorsal and ventral sacral foramina					
Spinous process					
Transverse process					
Cranial and caudal articular processes					
Coastal facet					
Mammillary process					
Accessory process					
Medial sacral crest					
Lateral sacral crest					
Hemal process					

Chapter 4: **THORAX**

INSTRUCTION:

The Bony thorax or thoracic cavity resembles an irregularly truncated cone and is best described and appreciated in a mounted skeleton. Therefore examine the mounted skeleton of any domestic species (Bovine, Caprine, Ovine, Equine, Porcine, Canine and Feline) to identify the following boundaries:

Dorsal wall or roof: Formed by the thoracic vertebrae and associated intervertebral discs.

Lateral wall: Formed by the ribs and costal cartilages.

Ventral wall or floor: Formed by the sternum.

Thoracic inlet or cranial aperture:
Dorsally - The first thoracic vertebra
Laterally - The first pair of ribs and their costal cartilages
Ventrally - The manubrium of the sternum

Thoracic outlet or caudal aperture:
Dorsally - The last thoracic vertebra
Laterally - The last few ribs along the line of attachment of the diaphragm and by the cranioventral part of the cost arch.
Ventrally - The xiphoid cartilage of the sternum.

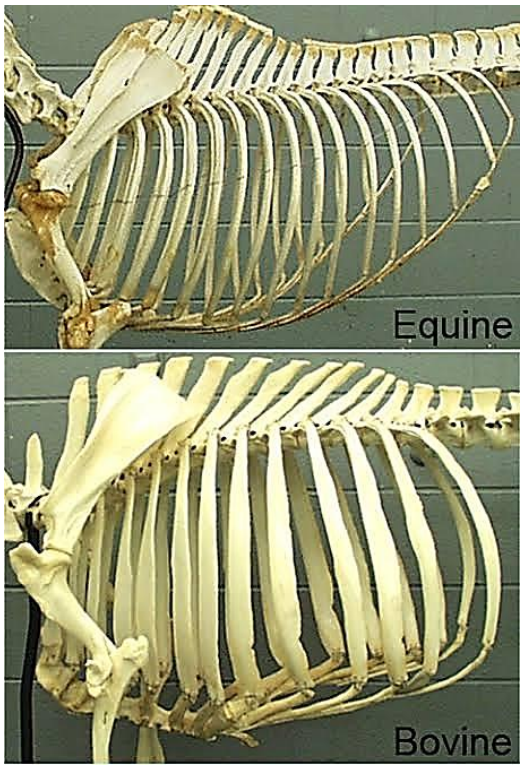


Figure 4.0: Equine and Bovine bony thorax

INSTRUCTION:

Note the positions of the following components of the thoracic cavity as described below:

Ribs

These are elongated, curved bones arranged serially in pairs to correspond in number to the thoracic vertebrae and form the skeleton of the lateral thoracic walls.
Each articulates dorsally with two adjacent vertebrae and continues ventrally by a costal cartilage. A true or sternal rib articulates with the sternum by means of its cartilage, the remaining

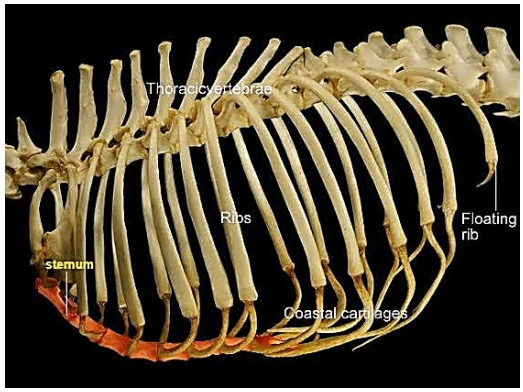


Figure 4.1: Canine bony thorax

are false or asternal ribs. Floating ribs are not attached to an adjacent cartilage but have their ventral end free and are located at end of the series. Intercostal spaces are the intervals between the ribs. Ribs from different parts of the series vary greatly in length, curvature and other characteristics.

Coastal cartilage

These are bars of hyaline cartilage which continue the ribs ventrally with those of the true ribs articulating with the sternum and those of the false ribs overlapping and attached to each other by elastic tissues to form the costal arch. Those of floating ribs do not attach to those adjacent.

The first costal cartilage has a very wide and thick dorsal end but small sternal end. The cartilages of the other sternal ribs increase progressively in length and become more rounded with enlarged sternal end and an elliptical convex facet for articulation with the sternum.

The asternal cartilages are long, slender and pointed and overlap and attach to each other by elastic tissue to form the **costal arch**. Except in the case of the first, the cartilages form with the ribs an angle which is open cranially and increases in size from the second to last. The first cartilage continues in the direction of the rib.

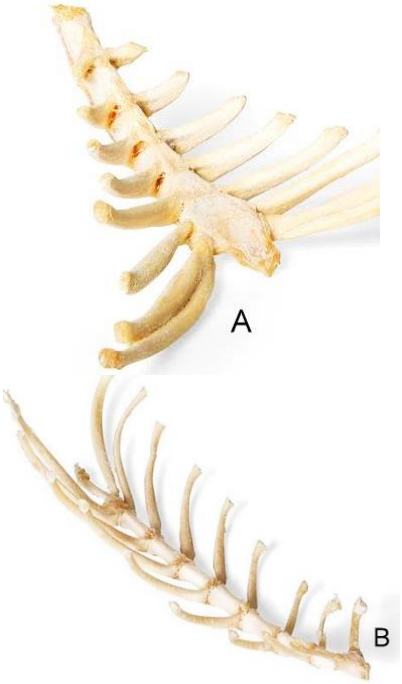


Figure 4.2: Sternum with coastal cartilages (Dorsal views). A- Equine, B- Canine

Sternum

This is a median segmental bone which completes the skeleton of the thorax ventrally and articulates with the cartilages of the sternal ribs laterally. It consist of seven sternebrae (connected by intervening cartilage) that is divided into 3 parts as follows:

Pre-sternum/manubrium sterni /cranial extremity:
This constitutes the most cranial part of the sternum and projects in front of the second intercostal junction. It

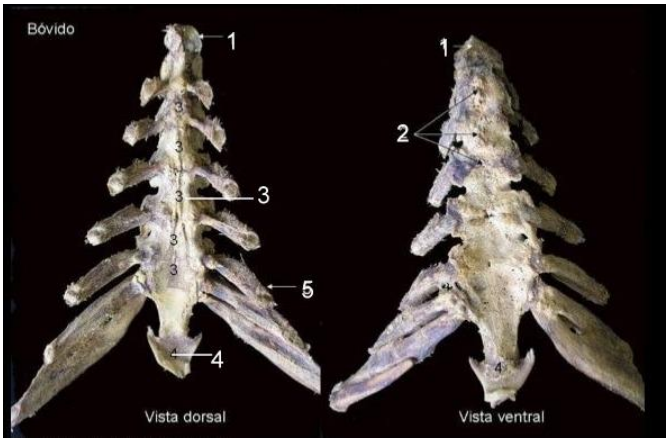


Figure 4.3: Bovine sternum with coastal cartilages (Dorsal and ventral views)
1, Manubrium sterni, 2, Ventral crest, 3, sternebra, 4, Xyphoid process, 5, Coastal cartilage.

is small and laterally compressed in the horse and ox, rudimentary in the dog. The cartilages of the first pair of ribs articulate with it.
The manubrium sterni is prolonged by cartilage, which has the shape of a short, blunt cylinder in carnivores, while it is a long, dorsally convex and laterally compressed projection in the horse. In ruminants this cartilage is represented by a thin layer only or is absent.

Meso-sternum/Corpus sterni:
The body of the sternum is cylindrical in carnivores, wide and flat in ruminants, and carries a ventral crest in the horse. It is composed of four to six segments, depending on the species (dog 8–9, ruminant and horse 7-8, pig 6). It is a uniform cylinder in cats, but in the dog it is rectangular, being higher than it is wide. In ruminants and the pig it is dorsoventrally compressed, whereas in the horse it is laterally compressed and extends ventrally. The mesosternum presents laterally, at the junction of the segments, concave facets for articulation with the cartilages of the sternal ribs.

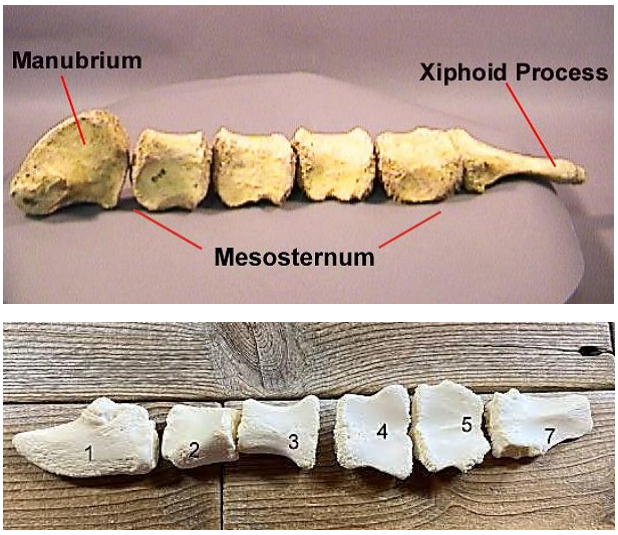


Figure 4.4: Caprine and porcine sternum showing lateral and dorsal views respectively.

Meta-sternum/Xyphoid process/Caudal extremity:
This is the last sternebra, which extends into a cartilagenous process (xyphoid cartilage) caudally. It projects between the ventral parts of the costal arches. The plate is thin and wide in the horse and ox, narrow and short in the dog.

INSTRUCTION:

Pick up the **ribs** of the **any domestic species** from the non-articulated bone collection to identify and study their features as described below:

A typical rib consists of a body and two extremities. The body is band-like with a pronounced curvature termed angle of the rib in the dorsal third and marked by a rough ridge. The ventral part is twisted and inclined medially. The lateral surface is convex in its length and grooved longitudinally in its cranial part. The medial surface is smooth and concave in its length. The costal groove is situated caudally and very distinct dorsally but fades out about the middle. The cranial and caudal borders are thin and sharp on some ribs, rounded on others.

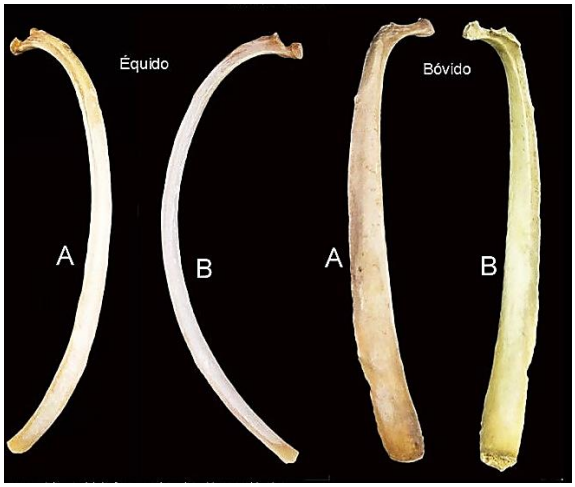


Figure 4.5: Equine and bovine ribs (cranial and caudal views.

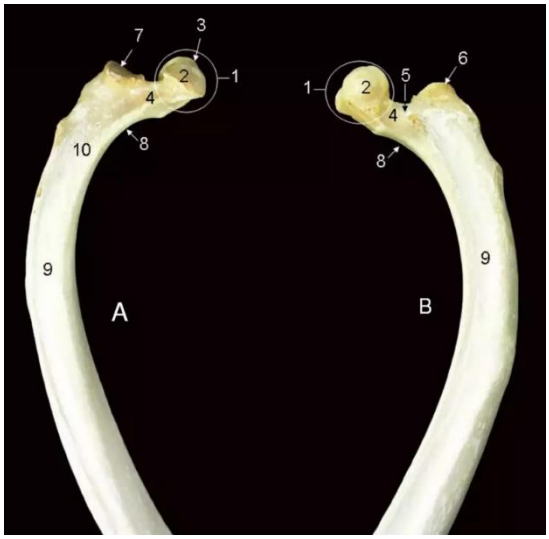


Figure 4.6: Bovine rib (A-caudal and B-cranial views)
1, Head, 2, articular facet, 3, articular crest, 4, neck, 5, crest of the neck, 6, Tubercle, 7, articular surface of tubercle, 8, Angle of rib, 9, Body of rib, 10, Groove.

ACTIVITY:

Answer the questions on the picture below and sketch the cranial thoracic inlet of any named species.



Bone _____
Species _____
View_____
Label the parts using arrows

Cranial thoracic inlet

Chapter 5: **FORE LIMB**

The Fore limb of domestic animals is composed of four chief segments:

Thoracic girdle, Arm (humerus), Forearm (radius and ulna), Manus (carpus, metacarpus and digits [phalanges and sessamoid bones).

N.B: The Thoracic girdle consists of the *scapula* (large, well developed flat bone that presents a small fused coracoid process) and the *clavicle* which is usually lacking in some species such as ruminants, equine, porcine and canine but present in primates and rodents.

INSTRUCTION:

Identify the bones of the forelimb on the articulated skeleton of any domestic animal by locating their positions as described below:

Scapula – A flat triangular shaped bone situated on the cranial part of the lateral wall of the thorax and extending obliquely from the vertebral end of the seventh or eighth rib to the sternal end of the first rib. It inclines obliquely between the thorax dorsomedially and the humerus distally.

Humerus - A long bone which extends from the shoulder dorsally, where it articulates with the scapula, to the elbow distocaudally, where it articulates with the radius and ulna. It is directed obliquely downward and backward, forming an angle of about 55 degrees with a horizontal plane.

Radio-ulna – These are two long bones articulating with each other. The ulna is placed caudal/caudolateral to the radius in the proximal part of the forearm and lateral in the distal part. It inclines vertically between the humerus proximally and carpus distally.

Carpus – A group of short rectangular bones arranged in two transverse rows. The proximal row articulates dorsally with the radio-ulna bone while its distal row articulates with metacarpal.

Metacarpal – These are long bones which may be two, three, four or five depending on the species. All bones may articulate proximally with the distal row of the carpals while all or some anchor the digits distally.

Phalanges – These are long bones which are usually three in number and succeeding each other. Each arrangement of three bones makes a digit. The number of digits depends on the species of animal.

INSTRUCTION:

Pick up the above-mentioned bones of the **ruminant species (Bovine, Caprine, Ovine)** from the non-articulated bone collection to identify and study their features as described below:

Scapula

It presents an irregular triangular outline having two surfaces (Lateral and medial), three borders (dorsal or vertebral, cranial or cervical and caudal) and three angles (cranial or cervical, caudal and ventral or glenoid angle).

The *lateral surface* is divided unequally into two fossae (Supraspinous and infraspinous) by a prominent *scapula spine* which extends from the dorsal border to the neck of the bone where it forms a pointed projection known as the *acromion process.* The free edge of the spine is thick, rough and in great part subcutaneous in the live state of the animal. A little above its middle is a non-distinct prominence, the *tubercle of the spine*. The smaller *supraspinous fossa* is cranial to the spine, while the larger *infraspinous fossa* is caudal to it. The *medial surface* bears a shallow depression the *subscapular fossa;* which occupies nearly the whole of the lower part of the surface, but is pointed above and separates two non-distinct triangular areas known as the *facies serrata.*

The *cranial or cervical border* is convex and rough above before becoming concave and smooth below, while the *caudal border* is somewhat straight bearing the nutrient foramen in its lower third. The *dorsal or vertebral border* carries the *scapular cartilage* which becomes calcified with age.

The *cranial or cervical angle* is at the junction of the cranial and vertebral borders. It is relatively thin and is about a right angle. The *caudal angle* is at the junction between the caudal and vertebral borders. The *ventral or glenoid angle* is joined to the body of the bone by the neck of the scapula. It bears a circular *glenoid cavity* for articulation with the head of the humerus. Cranial to the cavity is a rough prominence, the *supraglenoid tubercle*. The *coracoid process* projects from the medial side of this tubercle.

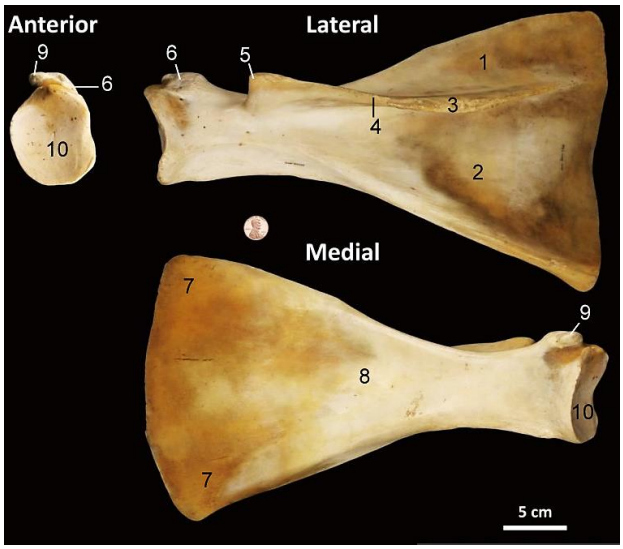


Figure 5.0: Bovine Scapula
1, Supraspinous fossa, 2, Infraspinous fossa, 3, Spinal tubercle, 4, Scapula spine, 5, Acromion process, 6, Supraglenoid tubercle, 7, Facies serrata, 8, Subscapular fossa, 9, Coracoid process, 10, Glenoid cavity.

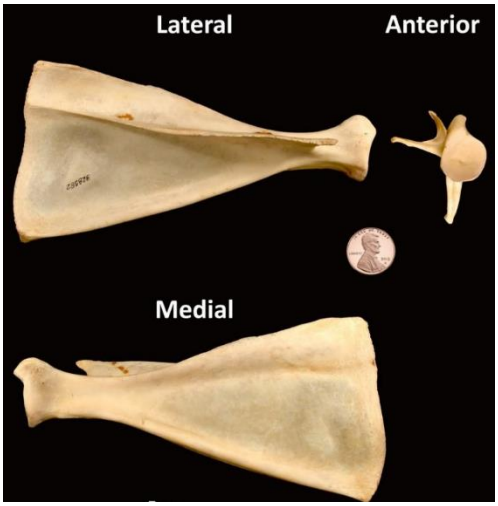


Figure 5.1: caprine scapula. Lateral, Medial and ventral views

INSTRUCTION:

Identify the scapula of the **Equine, porcine, canine and feline species** from the non-articulated bone collection to compare anatomical differences with that of the ruminants as described below:

Comparative Anatomy:

Equine (Horse):
The lateral surface is almost divided equally (though the supraspinous is smaller) by the spine which gradually subsides at the neck hence the acromion process is absent. The medial surface presents a deep subscapular fossa separated above by distinct rough triangular areas (Facies serrata). The caudal border is slightly concave. The scapular cartilage extends over the caudal angle. The glenoid cavity is oval in outline with its margin cut to form the glenoid notch. The coracoid process is a short and rounded projection.

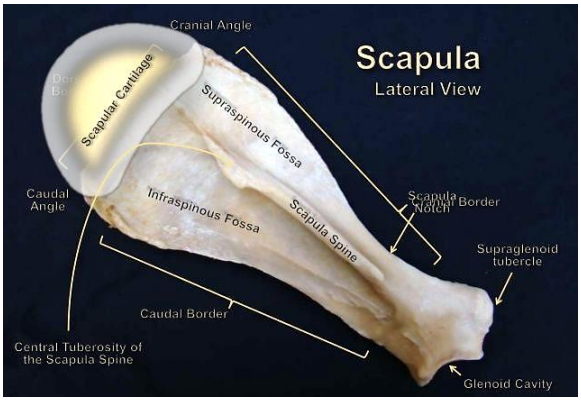


Figure 5.2: Equine Scapula. Lateral view with cartilage schematically inserted

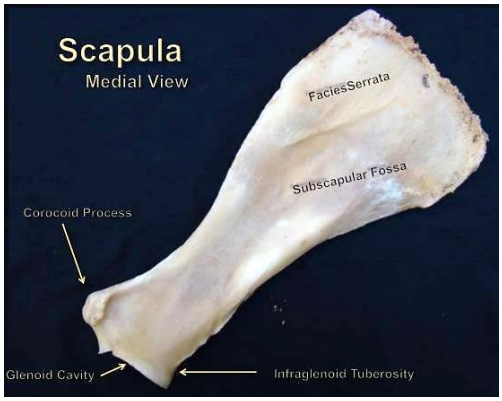


Figure 5.3: Equine Scapula. Medial view

Porcine (Pig):
The scapula is very wide in proportion to its length and presents a somewhat rhomboid shape due to the convexity of the cranial border. The spine is triangular, having a large spinal tubercle that curves backwards. The facies serrata is not clearly demarcated. The acromion process is more or less absent. The scapular cartilage is not as extensive as in bovine and equine.

Canine (Dog):
The scapula is relatively narrow in proportion to its length. Its spine is thick, centrally located and increases in size ventrally to form the acromion. The spinal tubercle is absent. The scapular cartilage is reduced to a thin band.

Feline (Cat):
The scapula is similar to that of the dog. The spine is centrally located, slightly concave above and straight below with the spinal tubercle between these parts. The acromion forms an extra process, the suprahamatus process caudally.



Figure 5.4: Porcine scapula. Medial view.

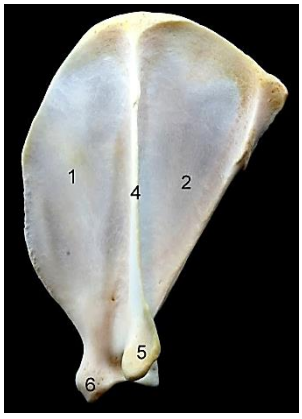


Figure 5.5: Canine scapula. Lateral view.

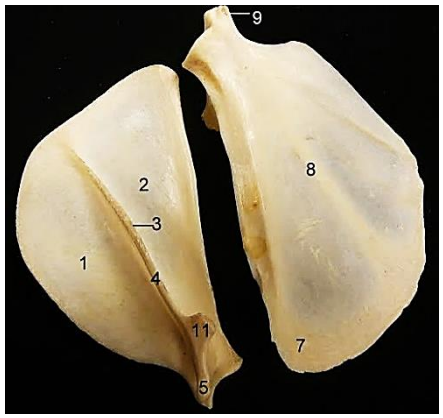


Figure 5.6: Feline scapula. Lateral and medial views.

1, Supraspinous fossa, 2, Infraspinous fossa, 3, Spinal tubercle, 4, Scapula spine, 5, Acromion process, 6, Supraglenoid tubercle, 7, Facies serrata, 8, Subscapular fossa, 9, Coracoid process, 10, Glenoid cavity, 11, Suprahamatus process.

ACTIVITY: Sketch and label the lateral and medial views of the porcine and canine scapula respectively. Also compare the features of the scapula in these species using + for presence and – for absence.

Porcine scapula (lateral)	Canine scapula (medial)

Features	Ox	Horse	Pig	Dog	Cat
Rhomboid					
Acromion process					
Spinal tubercle					
Suprahamatus process					
Triangular					
Coracoid process					
Scapular cartilage					

Humerus

The Humerus is a long bone which consists of a shaft or body with two extremities (proximal and distal).

The ***shaft*** is irregularly cylindrical having a twisted appearance with four surfaces (lateral, medial, cranial and caudal).
The *lateral surface* is smooth and is spirally curved, bearing the deltoid tuberosity at the middle and a shallow musculo-spiral groove at its distal third. The groove is continuous with the caudal surface and winds around toward the front. The deltoid tuberosity is absent in small ruminants (sheep and goat).
The *medial surface* is nearly straight in its length, rounded from side to side, and blends with the cranial and caudal surfaces. Just above its middle is the teres major tubercle (which may be absent in small ruminants).
The *cranial surface* is rough having a somewhat rectangular part above and a narrow part below. The deltoid tuberosity marks the boundary between this surface and the lateral surface.
The *caudal surface* is also rough, concave at its proximal first and continues straight till reaches the end. The nutrient foramen is in the lower third of this surface.

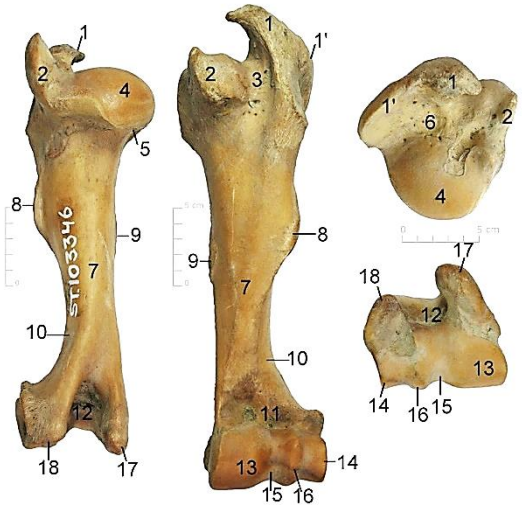


Figure 5.7: Bovine Humerus (Caudal, cranial views, proximal and distal extremities). 1, Greater tuberosity (Cranial part), 1' caudal part, 2, lesser tuberosity, 3, Bicipital groove, 4, Head, 5, Neck, 6, Fossa, 7, Shaft, 8, Deltoid tuberosity, 9, Teres major tubercle, 10, Musculospiral groove, 11, Coronoid fossa, 12, Olecranon fossa, 13, Medial condyle, 14, Lateral condyle, 15, Sagittal groove, 16, Shallow ridge, 17, Medial epicondyle, 18, Lateral epicondyle.



Figure 5.8: Caprine Humerus (Cranial, medial, caudal, lateral views, Proximal and distal extremities).

The ***proximal extremity*** consists of a head, neck, two tuberosities and the bicipital groove. The *head* which is entirely caudal presents an almost circular convex articular surface. Cranial to the head is a fossa in which are several foramina.
The *neck* is well defined caudo-ventrally, but is practically absent elsewhere.
The *greater tuberosity* is large, placed cranio-lateral rising above the level of the head. It consists of two parts; the cranial part forms the outer boundary of the bicipital groove, curving inward over the groove.

The lesser (medial) tuberosity is less salient, also consisting of cranial and caudal parts; the cranial part forms the inner boundary of the bicipital groove. It has a small projection which curves over the groove.

The ***distal extremity*** has an oblique surface for articulation with the radius and ulna, which consists cranially of two condyles and caudally of two epicondyles respectively.
The *medial condyle* is larger than the lateral and separated from it by a sagittal groove which runs craniocaudal to meet the olecranon fossa caudally. On the cranial surface and dorsal to the condyles is the radial or coronoid fossa.
The *lateral condyle* is much smaller and is placed somewhat lower and further back, giving the extremity an oblique orientation; it is marked by a wide shallow ridge.
The epicondyles are two unequal ridges located caudal to the condyles.
The medial epicondyle is the more pronounced of the two while the lateral epicondyle bears externally the lateral supracondyloid crest, which forms here the outer boundary of the musculo-spiral groove. Between the epicondyles is the deep olecranon fossa.

INSTRUCTION:

Identify the Humerus of the **Equine, porcine, canine and feline species** from the non-articulated bone collection to compare anatomical differences with that of the ruminants as described below:

Comparative Anatomy:

Equine (Horse):
The lateral (greater) tuberosity is at the same level as the head. The bicipital or intertubercular groove is bounded by the cranial parts of the tuberosities, and is subdivided by an intermediate ridge.

Porcine (Pig):
The humerus is strongly curved and short. The musculospiral groove is shallow.

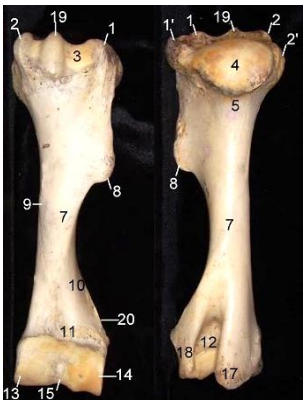


Figure 5.9: Equine Humerus (Cranial and caudal views).



Figure 5.10: Porcine Humerus (A-lateral, B-caudal, C-cranial, D-medial views).

1, Greater tuberosity (Cranial part), 1' caudal part, 2, lesser tuberosity (cranial part), 2', caudal part 3, Bicipital groove, 4, Head, 5, Neck, 6, Fossa, 7, Shaft, 8, Deltoid tuberosity, 9, Teres major tubercle, 10, Musculospiral groove, 11, Coronoid fossa, 12, Olecranon fossa, 13, Medial condyle, 14, Lateral condyle, 15, Sagittal groove, 16, Shallow ridge, 17, Medial epicondyle, 18, Lateral epicondyle, 19, Intermediate tubercle, 20, Supracondyloid crest.

Canine (Dog):
The musculospiral groove is shallow. The deltoid and teres major tuberosity are not prominent. The bony partition between the radial and olecranon fossae is usually absent forming a large supracondyloid foramen.

Feline (Cat):
The Humerus is straight in outline having a shallow musculospiral groove. The sagittal groove and ridge are deeper and well-marked respectively. The supracondyloid foramen is present above the medial condyle.

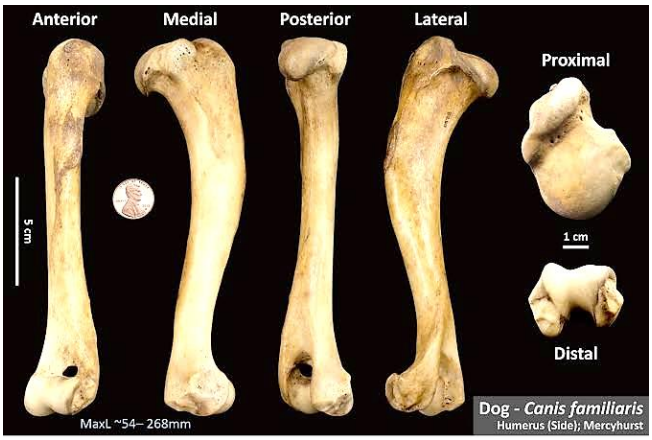
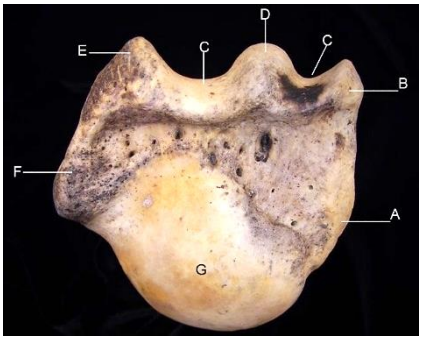
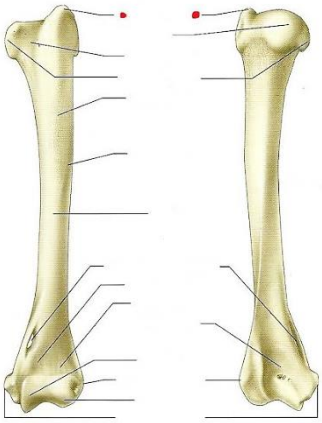


Figure 5.11: Canine Humerus (Cranial, medial, caudal and lateral views).

ACTIVITY: Identify the lettered parts of the _____(part of bone) of _____ (species) in the picture. Sketch its distal extremity in the space provided. Label the schematic diagram of the feline humerus. Also compare the features of the Humerus in these species using + for presence and – for absence.



A _____
B _____
C _____
D _____
E _____
F _____
G _____



Distal extremity of _____ humerus.

Features	Ox	Horse	Pig	Dog	Cat
Double bicipital groove					
Intermediate tuberosity					
Deep musculo-spiral groove					
Deltoid tuberosity					
Teres major tubercle					
Supracondyloid foramen					
Supracondyloid crest					

Radio-ulna

The **Radius** consists of a shaft and two extremities (Proximal and distal)

The ***shaft*** is curved in its length, somewhat flattened and expanded at its ends. It presents two surfaces (cranial and caudal) and two borders. The cranial surface is smooth, slightly convex in its length, and rounded from side to side. The caudal surface is correspondingly concave in its length.

The ***proximal extremity*** is flattened cranio-caudally and wide transversely presenting an articular surface which corresponds to that on the distal end of the humerus; it is crossed by a central sagittal ridge, which has a synovial fossa on its caudal part, and ends in front at a prominent lip, the coronoid process. Just below the caudal border are two facets for articulation with the ulna. Two eminences protrude lateral and medial to the articular facet of the radial head to give attachment to the ligaments of the joint. At the dorsomedial aspect of the radial head is the radial tuberosity; to which the biceps muscle tendon inserts.

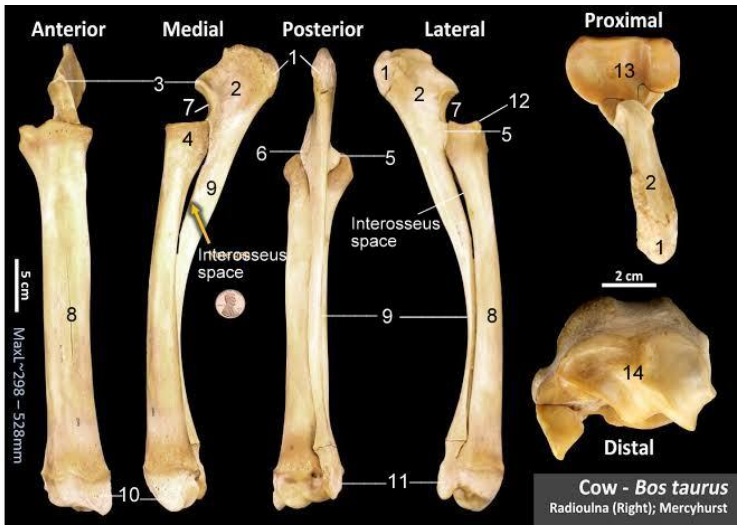


Figure 5.12: Radio-ulna of the Bovine. 1, Olecranon tuber, 2. Olecranon, 3, Anconeal process, 4, Radial tuberosity, 5, Lateral coronoid process of Ulna, 6, Medial coronoid process of Ulna, 7, Sigmoid, semi-lunar or trochlear notch, 8, Shaft of radius, 9, Shaft of Ulna, 10, Medial styloid process, 11, Lateral styloid process, 12, Coronoid process of Radius, 13, Articular surface for humerus, 14, Articular surface for carpus.

The ***distal extremity*** presents the carpal articular surface which consists of three parts. The inner facet is the largest and articulates with the radial carpal bone, the middle one articulates with the intermediate carpal bone while the outer facet articulates with the ulnar carpal bone. The cranial surface of this extremity presents grooves, separated by ridges. The caudal aspect is crossed by a rough ridge, below which are three depressions. The radius extends on the medial side to form the radial styloid process.

The **Ulna** also consists of a shaft and two extremities (Proximal and distal).

The ***shaft*** is three-sided and curved

The ***proximal extremity*** presents a massive structure, the olecranon which projects upward and somewhat backward. It forms a lever arm for the extensor muscles of the elbow. Attached to the free end of the olecranon is a rough tuberosity termed the olecranon tuber. The cranial border bears on its middle a pointed projection, the anconeal process which overhangs the semilunar (trochlear or sigmoid) notch. On both sides of the anconeal process project the lateral and medial coronoid processes.

The ***distal extremity*** continues as the prominent lateral styloid process which articulates with the proximal row of the carpal bones.

The **Radius and Ulna** are fused at their shaft by soft tissue membranes or by bony fusion. The cranial surface of the ulna is applied to the caudal surface of the radius. Between the shafts of the two bones there are two interosseous spaces (proximal and distal). A groove connects the two spaces externally.

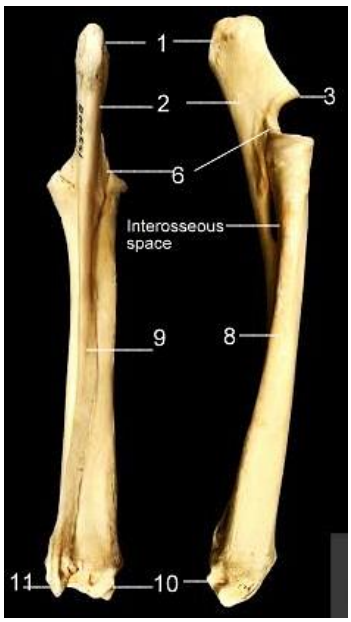


Figure 5:13: Radio-ulna of the Ovine (Caudal and Medial views). 1, Olecranon tuber, 2. Olecranon, 3, Anconeal process, 4, Radial tuberosity, 5, Lateral coronoid process of Ulna, 6, Medial coronoid process of Ulna, 7, Sigmoid, semi-lunar or trochlear notch, 8, Shaft of radius, 9, Shaft of Ulna, 10, Medial styloid process, 11, Lateral styloid process.

INSTRUCTION:

Identify the Radius and Ulna of the **Equine, porcine, canine and feline species** from the non-articulated bone collection to compare anatomical differences with that of the ruminants as described below:

Comparative anatomy

Equine (Horse):
The outer facet on the distal extremity of the radius is smaller, convex, and articulates below with the ulnar carpal and behind with the accessory carpal. The ulna is a reduced long bone situated behind the radius, with which it is partially fused (not extending to the distal extremity of the radius) in the adult giving rise to one interosseus space proximally. The styloid process of the distal extremity is only formed by the radius.

Porcine (Pig):
The radius is short, thick and curves caudally. It increases in size distally. It is loosely united with the shaft of the ulna presenting only one interosseus space proximally. The ulna is larger than the radius.



Figure 5.14: Radio-ulna of the Horse. A-Cranial, B-Caudal, C-Medial and D-Lateral views.

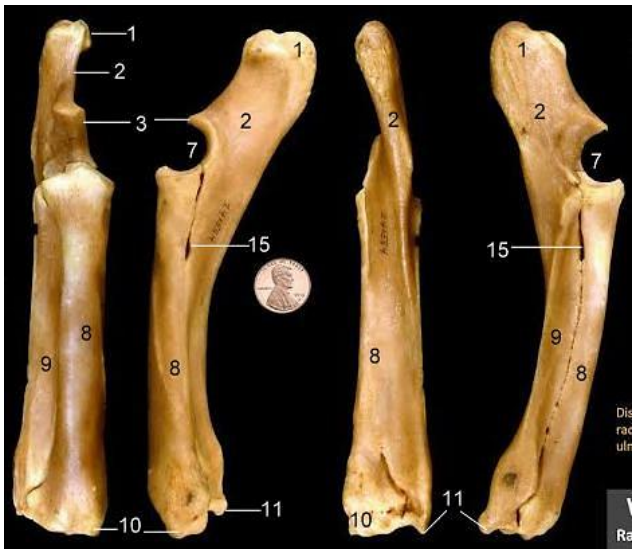
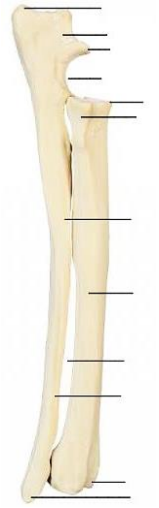


Figure 5.15: Radio-ulna of the Pig. Cranial, Medial, caudal and Lateral views.

1, Olecranon tuber, 2. Olecranon, 3, Anconeal process, 4, Radial tuberosity, 7, Sigmoid, semi-lunar or trochlear notch, 8, Shaft of radius, 9, Shaft of Ulna, 10, Medial styloid process, 11, Lateral styloid process, 12, Coronoid process of Radius, 15, Interosseous space.

Canine (Dog):
The radius is flattened cranio-caudally and increases in size distally. The shaft of the radius is separated from the ulna at the middle. The ulna is larger than the radius.

Feline (Cat):
The radius is curved but otherwise similar to that of the dog. The shaft of the ulna decreases in size distally.



ACTIVITY:

Name the view _____ of the _____ bone of the _____species in the picture. Label the pointed parts.

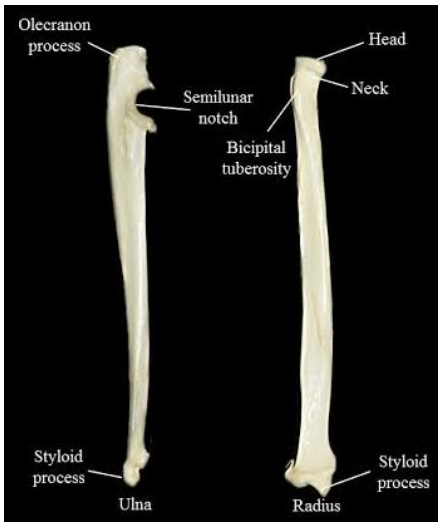


Figure 5.16: Feline Ulna and Radius

Carpus

This consists of a group of six (6) short bones arranged in two transverse rows, four (4) proximal and two (2) distal.

The ***proximal row*** articulates with radioulnar bone proximally and the bones are named mediolaterally as follows: the radial carpal, intermediate carpal, ulnar carpal and accessory carpal bones. The accessory carpal bone articulates with the ulnar carpal.

The ***distal row*** consists of two bones; the medial bone is the second and third carpal bones fused together and the lateral is the fourth carpal bone.



Figure 5.17: Bovine carpus (cranial view).



Figure 5.18: Bovine carpus (caudal view)

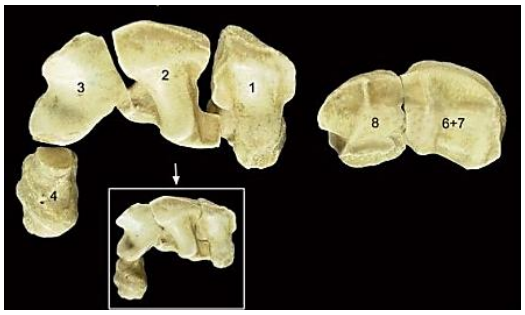


Figure 5.19: Bovine carpus (dorsal articular surface).

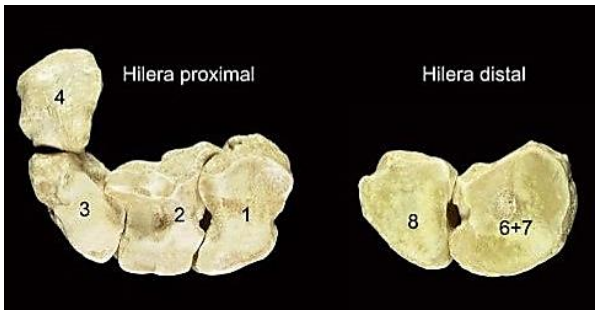


Figure 5.20: Bovine carpus (ventral articular surface)

1, Radiocarpal, 2. Intermediate carpal, 3, Ulnacarpal, 4, Accessory carpal, 6+7, Secon and third carpal fused, 8, Fourth carpal.

INSTRUCTION:

These ruminant carpal bones should be carefully examined to identify each as shown in the figures. Also locate and identify the carpal bones of the **equine, porcine, canine** and **feline** species and compare the number with that of the ruminants as described below. Doing this on an articulated skeleton would be more successful.

Comparative anatomy

Equine (Horse):
The carpus consists of seven (7) carpal bones; 4 proximal row (radial carpal, intermediate carpal, ulnar carpal and the accessory carpal which articulates with the ulnar carpal and radius) and 3 distal row (2nd, 3rd and 4th carpals).



Figure 5.21: Equine Carpus (caudal, cranial and lateral views). 1, Radio carpal, 2, Intermediate carpal, 3, Ulna carpal, 4, Accessory carpal, 5, Second carpal, 6, Third carpal, 7, Fourth carpal.

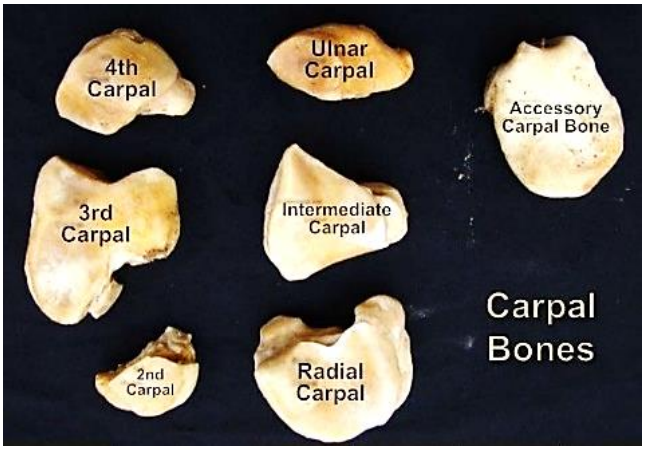


Figure 5.22: Equine carpals

Porcine (Pig):
The carpus consists of the complete number of eight (8) bones; 4 proximal (radial carpal, intermediate carpal, ulna carpal and accessory carpal) and 4 distal (1st, 2nd, 3rd and 4th carpals).

Canine (Dog) and Feline (Cat):
The carpal bones are seven (7) in number; 3 proximal and 4 distal. The intermediate and radiocarpal bones are fused to form the intermedio-radial carpal while the ulna carpal and accessory carpals are present. The distal row consists of the 1st, 2nd, 3rd and 4th carpals.

ACTIVITY:

Using the illustration below, sketch the carpus of the Porcine. Label the carpal bones of figure 5.23 and compare the number of carpal bones in these species using + for presence and – for absence.

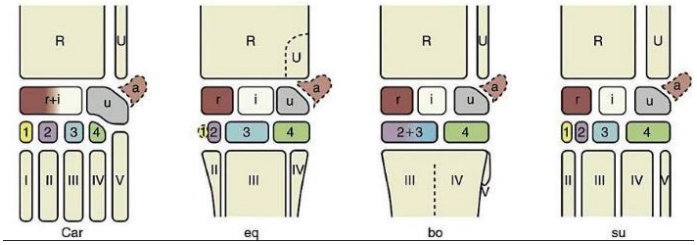




Figure 5.23: Carnivore carpus (Dorsal view).

	Carpal bones	Ox	Horse	Pig	Dog	Cat
	Radial carpal					
	Intermedioradial					
	Intermediate carpal					
	Ulnar carpal					
	Accessory carpal					
	First carpal					
	Second carpal					
	Third carpal					
	Fourth carpal					
Porcine carpus	2nd & 3rd carpal fused					

Metacarpals

The metacarpus consists of a ***large metacarpal*** and an external ***small metacarpal*** bone.

The large metacarpal bone results from the fusion of the third and fourth bones of the foetus, and bears evidences of its double origin even in the adult state. It has a shaft and 2 extremities (Proximal and distal).

The ***shaft*** is short, wide and somewhat flattened. The dorsal surface is rounded and is marked by a vertical vascular groove connecting two canals which traverse the ends of the shaft. The palmar surface is flat and presents a similar but much fainter groove. The borders are rough in the upper third.

The ***proximal end*** bears two slightly concave facets (with the medial facet larger) for articulation with the bones of the lower row of the carpus; they are separated by a ridge in front and a notch behind. The outer angle has a facet behind for the small metacarpal bone. The medial part of the extremity has dorsal and palmar tuberosities.

The ***distal end*** is divided into two parts by a sagittal groove. Each division bears a convex articular surface bearing a sagittal ridge.

The small metacarpal bone (may be absent in some breeds) is a rounded rod about an inch and a half in length, which lies against the upper part of the outer border of the large bone. Its upper end articulates with the latter, but not with the carpus. The lower end is pointed.

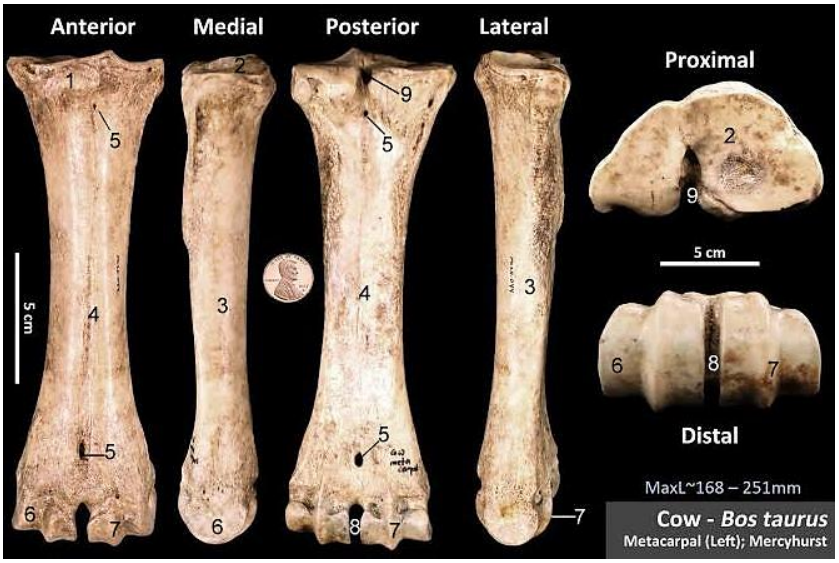


Figure 5.24: Bovine metacarpal. 1, Dorsal tuberosity, 2, Articular surface of proximal extremity, 3, Shaft, 4, Metacarpal groove, 5, Metacarpal canal, 6, Medial condyle, 7, Sagittal ridge, 8, Sagittal groove, 9, Notch.

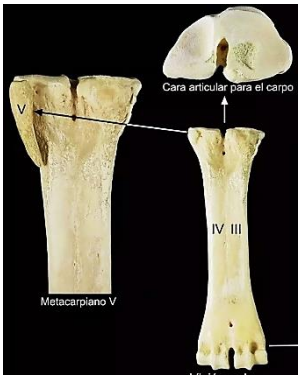


Figure 5.24b Bovine metacarpal (Caudal view)

INSTRUCTION:

Locate the Metacarpals of the **Equine, porcine, canine and feline species** from the non-articulated bone collection to compare anatomical differences with that of the ruminants as described below:

Comparative anatomy

Equine (Horse):
Three (3) metacarpal bones are present. Of these, only the third or large metacarpal bone, is fully developed and carries a digit; the other two, the second and fourth, are much reduced, situated on either side of the volar surface of the large metacarpal bone, and are commonly called the internal and external small metacarpal or "splint" bones. The shaft of the large metacarpal (canon bone) is semi cylindrical with smooth, convex and a nearly straight length. On either side of its upper two-thirds it is roughened for the attachment of the small metacarpal bones. The nutrient foramen occurs at the junction of the upper and middle thirds. The distal extremity presents an articular surface for the first phalanx and the proximal sesamoid bones, which is composed of a condyle, separated by a sagittal ridge.

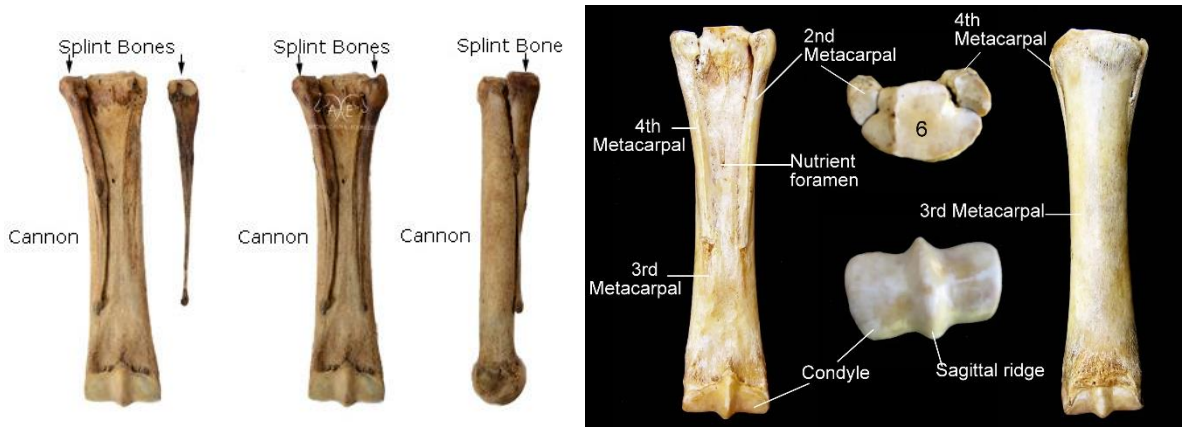


Figure 5.25: Equine metacarpals (caudal, lateral, proximal, distal and cranial views).

Porcine (Pig):
The second, third, fourth and fifth metacarpal bones are well developed with each carrying a digit.

Canine (Dog) and Feline (Cat):
It has five well developed metacarpal bones with each carrying its own digit composed of three phalanges except the first metacarpal bone which has two phalanges.



Figure 5.26: Porcine metacarpals

Phalanges and sesamoids

The general characteristics of phalanges in most species are as follows:

The First Phalanx: (Proximal phalanx, short canon, and Os suffraginis)

The first phalanx is a long bone, situated between the metacarpal bone above and the second phalanx below. It consists of a shaft and two extremities.

The *shaft* presents two surfaces and two borders. The dorsal surface is convex while the volar surface is flattened, and bears a triangular rough area that furnishes attachment to the sesamoidean ligaments. The borders, medial and lateral, are rounded and have a rough area or a tubercle on their middle parts.

The *proximal extremity* bears an articular surface adapted to the distal end of the large metacarpal bone, consisting of two glenoid cavities separated by a sagittal groove.

The *distal extremity* is smaller and presents a trochlea for articulation with the second phalanx, consisting of a shallow central groove and two lateral convex areas or condyles.

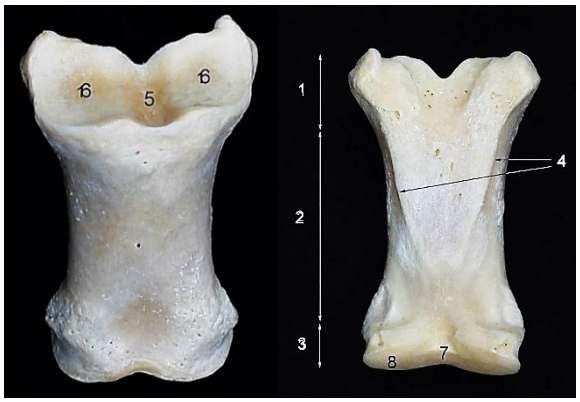


Figure 5.27: Equine first phalanx, dorsal and palmar views. 1, proximal extremity, 2, Body/shaft, 3, Distal extremity, 4, Triangular rough area, 5, Sagittal groove, 6, Proximal articular surface, 7, shallow central groove, 8, Convex condyles.

The Second Phalanx: (Intermediate Phalanx, Pastern bone, Os corona)

The second phalanx is situated between the first and third phalanges; it may be described as possessing four surfaces.

The *upper or proximal surface* presents two glenoid cavities separated by a low ridge, and articulates with the first phalanx.

The *distal surface* is a trochlear that articulates with the third phalanx and third sesamoid bone.

The *dorsal surface* is convex from side to side and smooth in its middle; on its lower part are lateral rough depressions, surmounted by tuberosities, to both of which ligaments are attached.

The *volar surface* is smooth and flattened.

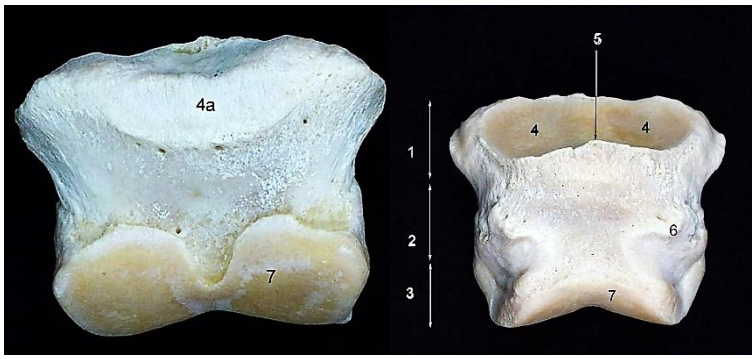


Figure 5.28: Equine second phalanx, palmar and dorsal views. 1, proximal extremity, 2, Body/shaft, 3, Distal extremity, 4a, articular surface, 5, Extensor process, 6, Tuberosity, 7, Trochlear.

The Third Phalanx: (Distal phalanx, Coffin bone, Os pedis)

The third or ungual phalanx is entirely enclosed by the hoof, to which it conforms in a general way. It presents for examination three surfaces, three borders, and two angles or wings.

The *articular surface* faces upward and backward, and is adapted to the distal surface of the second phalanx, but a narrow-flattened area along the caudal border articulates with the third sesamoid. The cranial or coronary border forms a central eminence, the extensor (or pyramidal) process, to the front of which the anterior extensor tendon is attached.

The *dorsal or wall surface* slopes downward and forward. It is perforated by numerous foramina of various sizes. The distal border is thin, sharp, and irregularly notched; there is commonly a wider notch in front.

The *volar surface* is arched, and divided into two unequal parts by a curved rough line, the semilunar crest. The larger cranial area is crescent-shaped, concave, and comparatively smooth; it corresponds to the sole of the hoof, and may be termed the sole surface. The caudal part is much smaller, and is semilunar; it is related to the deep flexor tendon, and is hence called the flexor or tendon surface.

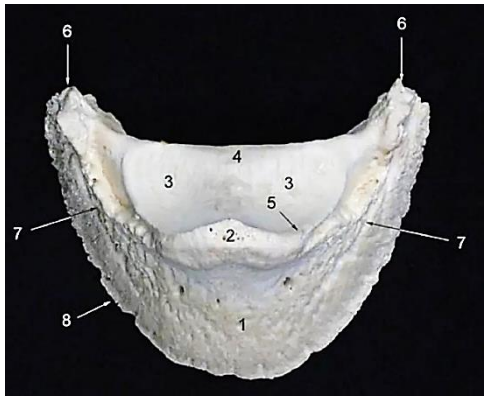


Figure 5.29: Equine distal phalanx, dorsal view. 1, Dorsal surface, 2, Extensor process, 3, Articular surface, 4, articular surface for articulation with sessamoid, 5, Dorsal border, 6, Palmar process, 7, Parietal sulcus, 8, Border of sole.

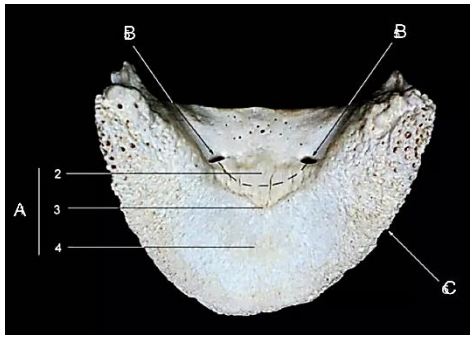


Figure 5.30: Equine distal phalanx, palmar view. A-Volar surface, B-Palmar foramen, C-Sole border, 1, Sole, 2, flexor surface, 3, Semilunar crest.

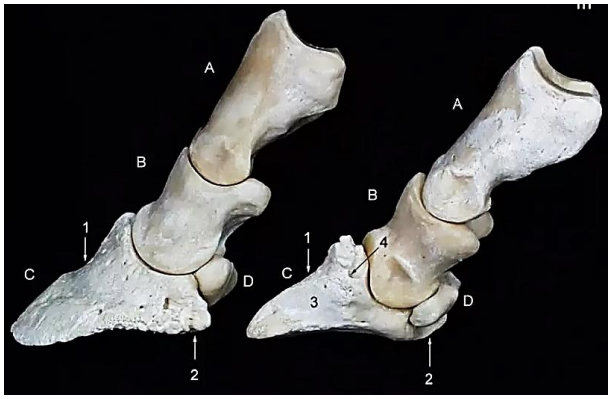


Figure 5.32: Bovine Digits, lateral and medial views. A-First phalanx, B-Second phalanx, C-Third phalanx, D-Distal sessamoid. 1, Dorsal surface, 2, Palmar process, 3, Medial surface.

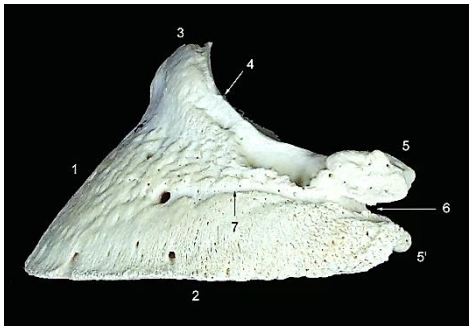


Figure 5.31: Equine distal phalanx, lateral view. 1, dorsal surface, 2, Sole border, 3, Extensor process, 4, Articular surface, 5, 5', Palmar process, 6, Palmar angle, 7, Parietal sulcus.

Comparative anatomy

Bovine (Ox), Caprine (Goat) and Ovine (Sheep):
Two digits—the third and fourth—are fully developed in the bovine, caprine and ovine. They have three phalanges and three sesamoids each. Four proximal sesamoids are present, two for each digit.

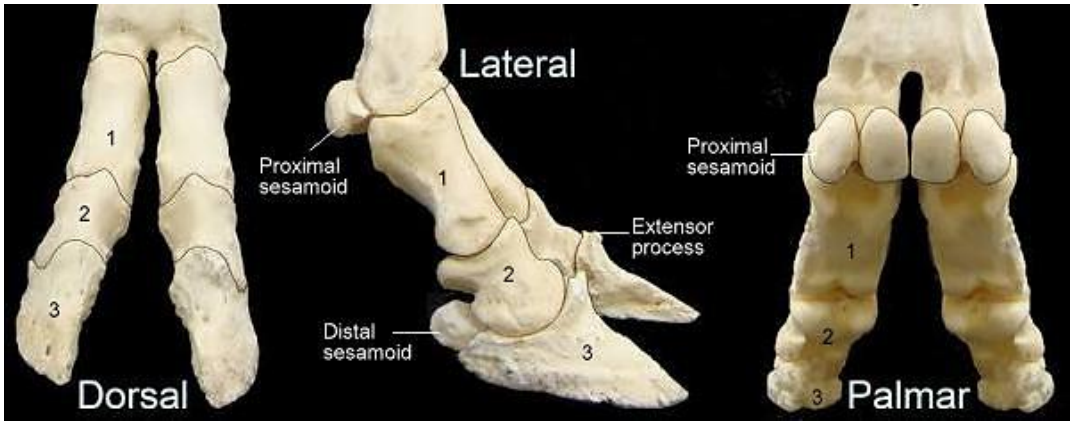


Figure 5.33: Caprine and Ovine Digits (Dorsal, lateral and palmar views).
1, Proximal phalanx, 2, Intermediate phalanx, 3, Distal phalanx.

Equine (Horse):
One digit per limb comprises three phalanges and three sesamoids. Two cube-like sesamoids are located between the distal end of metacarpal and proximal end of the 1st phalanx while the somewhat flattened distal sesamoid (Navicular bone) is between the distal end of the 2nd phalanx and articular surface of 3rd phalanx.



Figure 5.34: Equine digits (Dorsal and palmar views).
1, Os pedis, 2, Navicular bone, 3, Os corona, 4, Os suffraginis, 5, Prox. Sesamoid.

Porcine (Pig):
Each chief digit (3rd and 4th) comprises three phalanges and three sesamoids. The bones of the chief digits resemble those of the ox in form, but there is no foramen on the interdigital side of the extensor process and the proximal sesamoids are narrow and ridged behind. The phalanges of the accessory digits (which do not reach the ground ordinarily) are similar in form but much smaller and have two sesamoids each.

Canine (Dog):
The five digits have three phalanges each, except the first, which has two. The third and fourth digits are the longest; the first is very short and does not come in contact with the ground in walking. Each foot has a maximum of thirteen sesamoid bones

Feline (Cat):
Their Phalanges are similar in form and number to that of the Dog, but the forepaw has nine sesamoids, while the hind paw has eight sesamoids.



Figure 5.35: Porcine manus (Dorsal view).
1, 2nd metacarpal, 2, 3rd metacarpal, 3, 4th metacarpal, 4, 5th metacarpal with their digits.



Figure 5.36: Feline manus (Dorsal view).
1-5, First to fifth metacarpals with their digits.

ACTIVITY:

On page 94 is a schematic presentation of the dorsal view of the Canine manus, sketch that of the equine and caprine and in the space provided and compare their number in these species using + for presence and – for absence.

Equine manus	Caprine manus

Features	Ox	Horse	Pig	Dog	Cat
6-7 carpals					
8 carpals					
2-3 metacarpals					
4-5 metacarpals					
1-2 digits per limb					
4 digits per limb					
5 digits per limb					

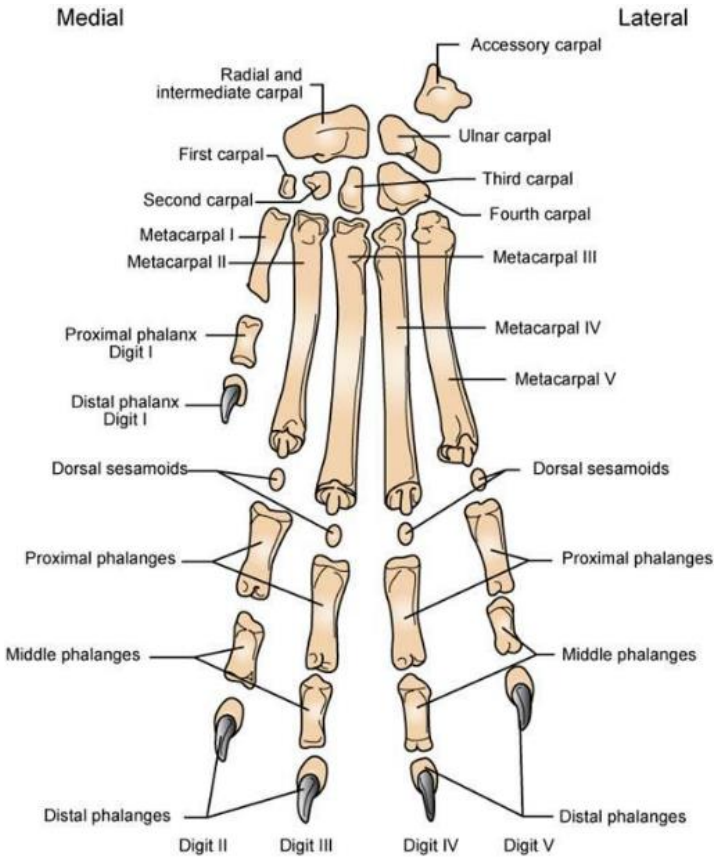


Figure 5.37: Canine manus

Chapter 6: **HIND LIMB**

The hind or pelvic limb consists of the pelvic girdle, thigh (femur and patella), leg (tibia and fibula) and pes (tarsus, metatarsus and digits).

INSTRUCTION:

Identify the bones of the hind limb on the articulated skeleton of any domestic animal by locating their positions as described below:

Pelvic girdle – This extends obliquely backward and consists of symmetrical hip bones (ossa coxarum), which meet at the pelvic symphysis ventrally forming firm articulations with the sacrum and first few caudal vertebrae dorsally. Augmentation by the sacrum and first few caudal vertebrae results in formation of a ring known as the bony pelvis around the pelvic cavity. The **ossa coxarum** are composed of the **os coxae** of each side, which form a cartilaginous joint along the median pelvic symphysis.

Thigh – This consists of a long femur (articulating with the acetabulum above and the tibia below) and the largest sesamoid bone; the patella placed cranial to the distal extremity of the femur which is obliquely oriented forward.

Leg – This consists of two long bones; the larger Tibia and slimmer Fibula joined at their proximal and distal ends. They extend obliquely downward and backward from the stifle to the hock.

Tarsus – A group of short irregularly shaped bones arranged in two rows. The proximal row articulates dorsally with the Tibia and fibula while its distal row articulates with the metatarsal.

Metatarsal – These are long bones which may be two, three, four or five depending on the species. All bones may articulate proximally with the distal row of the tarsals while all or some anchor the digits distally.

Phalanges – These are long bones which are usually three in number and succeeding each other. Each arrangement of three bones makes a digit. The number of digits depends on the species of animal.

INSTRUCTION:

Pick up the above-mentioned bones of the **ruminant species (Bovine, Caprine, Ovine)** from the non-articulated bone collection to identify and study their features as described below:

Os Coxae

The Os coxae forms the skeleton of the hip or haunch, and is the largest of the flat bones. It consists primarily of three parts, the *ilium, ischium,* and *pubis,* which meet to form the acetabulum, a large cotyloid cavity for articulation with the head of the femur. These parts are fused at about one year of age, but it is convenient to describe them separately.

The Ilium:

The ilium is the largest of the three parts. It is irregularly triangular and presents two surfaces, three borders, and three angles.

The ***dorsolateral or gluteal surface*** is wide cranially and narrow caudally. The wide part (wings) is crossed by the curved gluteal line, which is nearly parallel to the lateral border; joining the dorsal ischiatic spine. This surface gives attachment to the middle and deep gluteal muscles.

The ***ventromedial or pelvic surface*** consists of two distinct parts namely: the inner somewhat triangular part which is roughened for ligamentous attachment, and bears an irregular facet, the auricular surface, for articulation with the sacrum. The outer quadrilateral part is generally smooth. A rounded ridge separates the two parts of the ventral surface in Ox but in the Sheep and goat, it is separated by the Iliopectinal line.

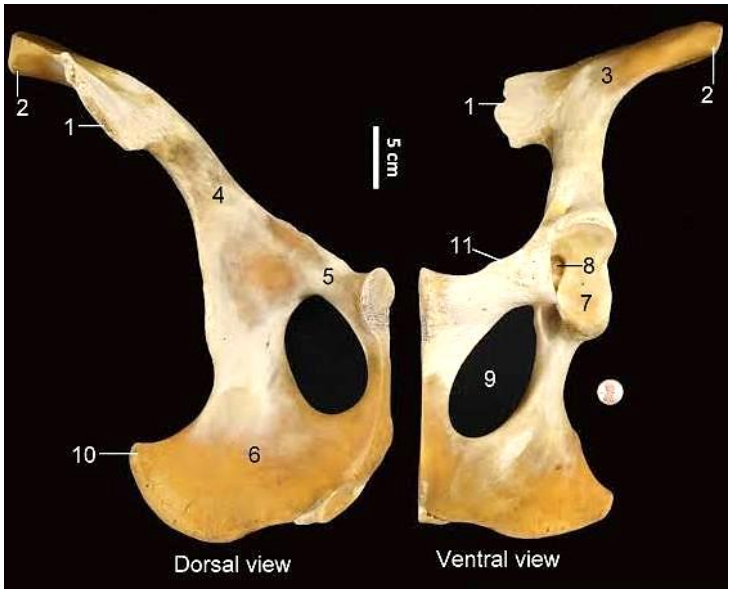


Figure 6.0: Bovine Os Coxae. 1, Sacral tuber, 2, Coxal tuber, 3, Wing of Ilium, 4, Shaft of Ilium, 5, Pubis, 6, Ischium, 7, Acetabulum, 8, Acetabular fossa, 9, Obturator foramen, 10, Ischial tuber.

The cranial border or crest is straight in the Ox, convex in sheep and concave in the goat.

The internal border is concave in the Ox but straight in the sheep and goat. Caudally and cranial to the acetabulum, it bears the psoas tubercle.

The external border is concave and in great part rough. The nutrient foramen is usually situated on or near the caudal part of this border.

The medial or sacral angle forms the sacral tuber. It is somewhat thickened and roughened.
The lateral or coxal angle forms the coxal tuber which is also roughened for muscular attachment. The two tubers are more prominent in the Ox and Goat than in the sheep.

The caudal or acetabular angle meets the other two bones at the acetabulum. Two depressions above and in front of the acetabulum give attachment to the tendons of origin of the rectus femoris muscle. This angle is connected with the ala or wide part of the bone by a constricted part, often termed the shaft.

The Ischium:
The ischium forms the caudal part of the ventral wall or floor of the bony pelvis. It is irregularly quadrilateral, and may be described as having two surfaces, four borders, and four angles.

The ***dorsal or pelvic surface*** is smooth and slightly concave from side to side.
The ***ventral surface*** is nearly flat, and is in great part roughened for the attachment of the adductor muscles.

The *cranial border* forms the caudal margin of the obturator foramen. The *caudal border* is thick and rough. It meets the border of the other side, forming with it the deep and narrow ischial arch. The medial border meets the opposite bone at the symphysis which bears a ventral ridge that fades out near the ischial arch. The *lateral border* is thick and rounded, but concave in its length.

The craniomedial angle or symphyseal branch meets the pubis, with which it forms the inner boundary of the obturator foramen. The craniolateral angle or acetabular branch joins the other two bones at the acetabulum. The caudolateral angle is a thick three-sided mass, the tuber ischii; bearing upper, lower, and external tuberosities.

The pubis:
The pubis is the smallest of the three parts of the os coxae. It forms the cranial part of the pelvic floor, and may be described as having two surfaces, three borders, and three angles.

The ***dorsal or pelvic surface*** is concave and smooth. The urinary bladder rests on it.
The ***ventral surface*** is convex, and in great part rough for muscular attachment.

The *cranial border* forms the pecten ossis pubis.
The internal border joins the opposite bone at the symphysis pubis.

The caudal border forms the cranial margin of the obturator foramen, and is marked laterally by the obturator groove.

The medial angle meets its fellow at the cranial end of the symphysis.
The lateral or acetabular angle joins the ilium and ischium at the acetabulum.
The caudal angle joins the ischium, with which it forms the inner boundary of the obturator foramen.

The pubis may conveniently be regarded as consisting of two branches which meet at a right angle; these are termed the transverse or acetabular branch and the longitudinal or symphyseal branch.

The ***obturator foramen*** is large and ellipsoidal in outline; situated between the pubis and ischium. It is oval in outline, its margin is grooved craniolaterally for the obturator nerve and vessels.

The ***acetabulum*** is a cotyloid cavity which lodges the head of the femur. It consists of an articular and a non-articular part. The articular part is crescentic, and is cut into internally by the non-articular part, which lies at a lower level, and is termed the acetabular fossa. The rim is interrupted by two acetabular notches in the Ox but only one in the Sheep and Goat.

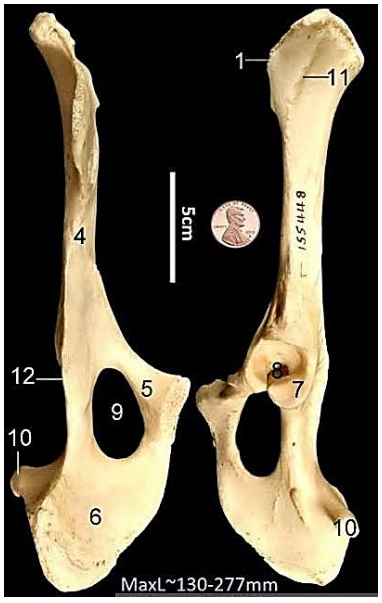


Figure 6.1: Ovine Os coxae (Dorsal and lateral views).

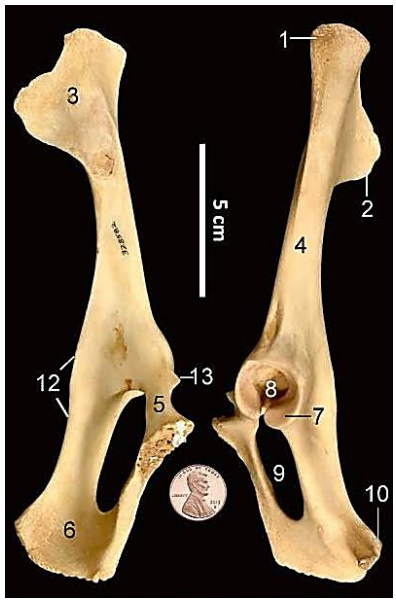


Figure 6.2: Caprine Os coxae (Medial and lateral views).

1, Sacral tuber, 2, Coxal tuber, 3, Wing of Ilium, 4, Shaft of Ilium, 5, Pubis, 6, Ischium, 7, Acetabulum, 8, Acetabular fossa, 9, Obturator foramen, 10, Ischial tuber, 11, Iliopectinal line, 12, Ischiatic spine, 13, Pubic eminence



Figure 6.2a: Acetabulum
1, Acetabular fossa, 2, Acetabular notch, 3, Articular part of cotyloid cavity.

INSTRUCTION:

Locate the Ossa coxarum of the **Equine, porcine, canine and feline species** from the non-articulated bone collection to compare anatomical differences with that of the ruminants as described below:

Comparative anatomy

Equine (Horse):
The gluteal surface of the Ilium faces upward, backward, and outward. It is wide and concave in front, narrower and convex behind. The pelvic surface is crossed by the ilio-pectineal line which begins below the auricular surface and is continued on the shaft of the bone to join the cranial border of the pubis. The line is interrupted by furrows for the iliaco-femoral vessels, and below these it bears the psoas tubercle, which gives attachment to the psoas minor muscle. The cranial border or crest is concave, thick, and rough. The Sacral tuber curves upward. The Coxal tuber is a large quadrangular mass, narrow in its middle, and enlarged at either end, where it bears a pair of tuberosities.
The dorsal or pelvic surface of the pubis is convex in the young subject and the stallion, concave and smooth in the mare and usually in the gelding also. The urinary bladder rests on it. Laterally, the cranial border bears the rough iliopectineal eminence, beyond which it is continuous with the ilio-pectineal line.
The inner part of the acetabular rim is cut into by an acetabular notch. The obturator foramen is oval in outline.

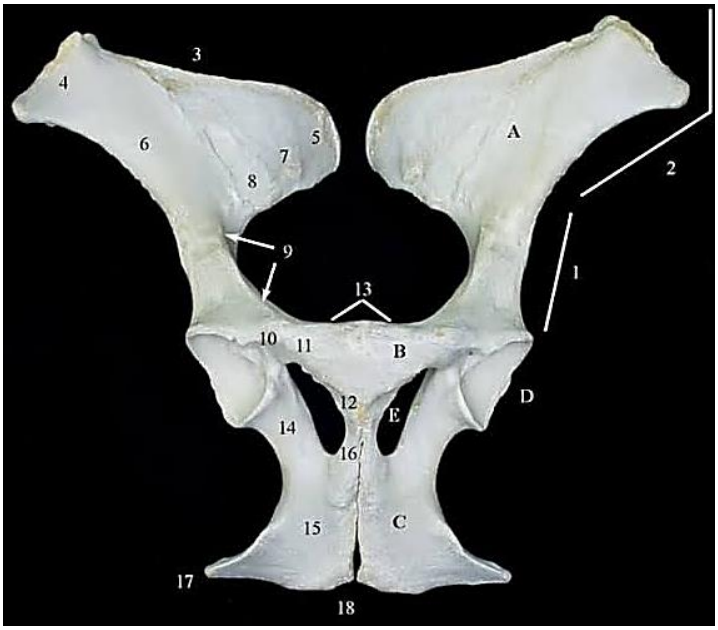


Figure 6.3: Equine Ossa coxarum (Ventral view)
A-Ilium, B-Pubis, C-Ischium, D-Acetabulum, E-Obturator foramen. 1, Shaft of Ilium, 2, Wing of Ilium, 3, Cranial border of ilium, 4, Coxal tuber, 5, Sacral tuber, 6, Quadrilateral part of ilium, 7, Triangular part, 8, Auricular surface, 9, Iliopectinal line, 10, Acetabular notch, 11, Acetabular branch of pubis, 12, Symphyseal branch of pubis, 13, Pubic eminence, 14, Body of Ischium, 15, Ischium, 16, Symphyseal branch of Ischium, 17, Ischial tuber, 18, Ischial arch.

Porcine (Pig):

The Os coxae is long and narrow. The ilium and ischium are almost in line with each other and sagittal in direction. The gluteal surface is divided into two fossae by a ridge, which is continuous with the dorsal ischiatic spine behind. The cranial border is convex. The inner surface presents an extensive rough area behind. The tubers are everted and bear three prominences. There is a crest or tuberosity on the ventral surface. The symphyseal part of the pubis is thick and the two bones are almost in a horizontal plane. The ilio-pectineal eminence is prominent and the psoas tubercle is well marked. The acetabulum is placed a little further back than in the ox. The rim is thick and is cut into caudally by a narrow fissure, which leads into the deep fossa acetabuli. The obturator foramen is round in outline.



Figure 6.4: Porcine Ossa coxarum (Ventral view). 1, Sacral tuber, 2, Coxal tuber, 3, Wing of Ilium, 4, Shaft of Ilium, 5, Pubis, 6, Ischium, 7, Acetabulum, 9, Obturator foramen, 10, Ischial tuber, 13, Pubic eminence, 14, Pelvic symphysis, 15, Ischial arc.

Canine (Dog):

The ilium is nearly parallel with the median plane and its axis is only slightly oblique with regard to the horizontal plane. The gluteal surface is concave. The iliac surface is almost flat. The auricular surface faces almost directly inward, and in front of it there is an extensive rough area. The ilio-pectineal line is very distinct and is uninterrupted. The cranial border is convex.

The ischial arch is relatively small and semi-elliptical.

The acetabular fossa is deep, and is bounded medially by a flat plate of bone. The obturator foramen resembles in outline an equilateral triangle with the angles rounded off.

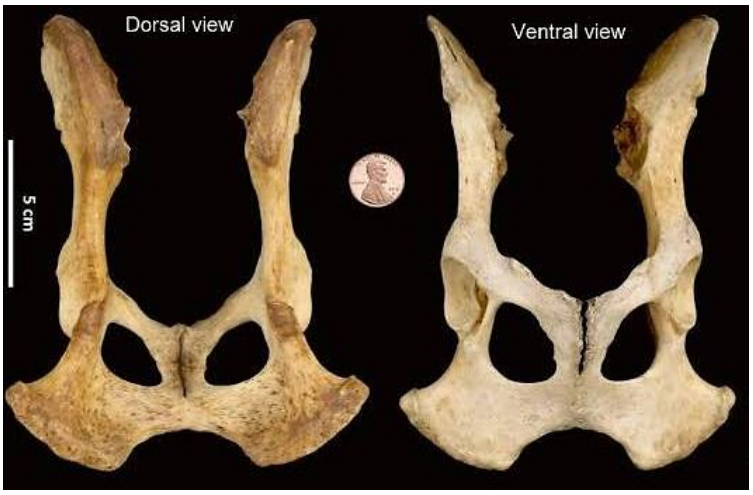


Figure 6.5: Canine Ossa coxarum.

Feline (Cat):
The ilium is similar to that of the dog. The ischium appears more rectangular due to the very small ischial arch. The acetabular fossa is shallow while the obturator foramen is large and ellipsoidal.



Figure 6.6: Feline Ossa coxarum (Vental view)

INSTRUCTION:
View the articulated skeleton of any species and locate the bony pelvis as described

Bony Pelvis

The bony pelvis is composed of the ossa coxarum, sacrum and first three caudal vertebrae.

The dorsal wall or roof is formed by the sacrum and caudal vertebrae.
The ventral wall or floor is formed by the pubis and ischial bones.
The lateral walls are formed by the ilia and acetabular part of the ischia. The skeletal deficit here is compensated for in the fresh state, by the broad sacrotuberal ligaments.

The cranial aperture or pelvic inlet is elliptical and oblique and bounded by the terminal line or brim which is composed of the base of the sacrum dorsally, the arcuate line laterally and pectin ossis pubis ventrally.

The caudal aperture or outlet is much smaller and very incomplete in the skeleton bounded dorsally by the third coccygeal vertebra, ventrally by the ischiatic arch and in the fresh state completed laterally by the broad sacrotuberal ligament and semimembranosus muscle to enclose the perineum.

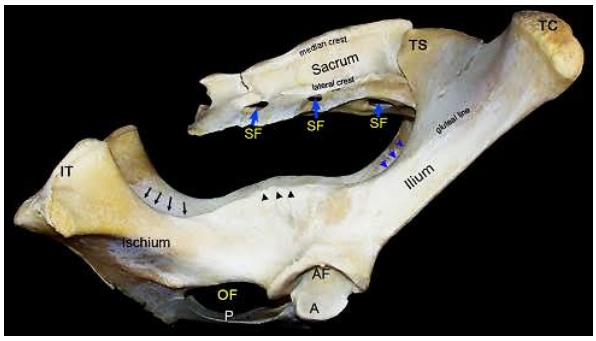


Figure 6.7: Bovine bony pelvis (Lateral view).

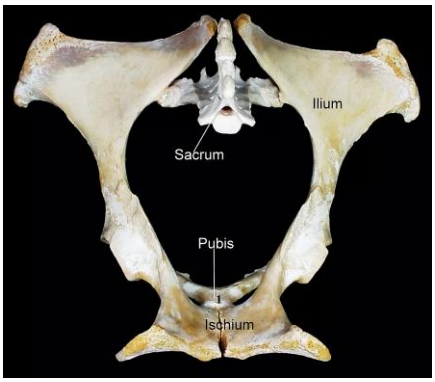
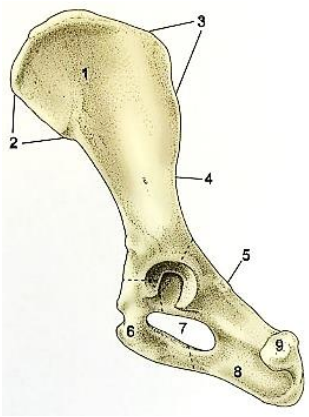


Figure 6.8: Equine bony pelvis (Dorso-caudal view).

ACTIVITY:
Name the view _____ of the _____ bone of the _____species in the schematic presentation and label the numbered parts.



Sketch and label the dorsal views of the Equine and Porcine Ossa coxarum.
Also sketch the cranial view of the bovine bony pelvis.
Compare the features of the Pelvic bone in these species using + for presence and – for absence.

Equine Ossa coxarum (dorsal view)	Porcine Ossa coxarum (dorsal view)	Bovine bony pelvis (Cranial view)

Features	Ox	Horse	Pig	Dog	Cat
Convex cranial iliac border					
2 notched acetabulum					
Ellipsodal Obturator foramen					
Crescent ischial arc					
Cotyloid cavity					
Pubic eminence					
Gluteal line					

Femur

The femur is the largest and most massive of the long bones. It presents for examination a shaft and two extremities.

The ***shaft or body*** is in general cylindrical but prismatic below. The cranial and lateral surfaces are continuous and strongly convex from side to side; there is often a central vertical rough line on the proximal part, but otherwise these surfaces are smooth. The medial border bears on its proximal first, the medial or minor trochanter. A narrow rough area is seen about the middle and the nutrient foramen is usually found just in front of this mark. The supracondyloid crest is situated below. The lateral border is smooth proximally. At the lower part is found the supracondyloid or plantar fossa.

The ***proximal extremity*** is large and consists of the head, neck, and greater trochanter. The *head* is placed medially. It is cut into medially by a small depression, the fovea capitis. The articular surface is surrounded by a distinct margin. The *neck* is most distinct in front and medially. The greater trochanter (Trochanter major) is situated laterally and connects to the minor trochanter obliquely via the trochanteric crest thereby creating the trochanteric fossa.

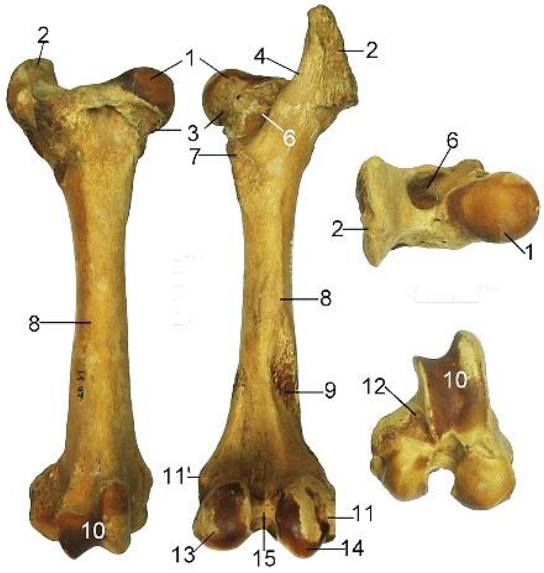


Figure 6.9: Bovine Femur (Cranial, caudal, proximal and distal views). 1, Head, 2, Greater trochanter, 3, Neck, 4, Trochanteric crest, 6, Trochanter fossa, 7, Lesser trochanter, 8, Shaft, 9, Supracondyloid fossa, 10, Trochlea, 11, Lateral epicondyle, 11', Medial epicondyle, 12, Extensor fossa, 13, Medial condyle, 14, Lateral condyle, 15, Intercondyloid fossa.

The ***distal extremity*** is large in both directions and comprises the trochlea in front and two condyles behind. The trochlea consists of two ridges separated by a groove, and forms an extensive surface for articulation with the patella. It is very unsymmetrical; the inner ridge or lip is much wider, more prominent, and extends up higher than the external one, and the two converge below. The condyles (medial and lateral) are separated by the deep intercondyloid fossa. The medial condyle is obliquely oriented. A ridge connects each condyle with the lower part of the corresponding lip of the trochlea. The medial epicondyle is a rounded prominence on the medial surface of the medial condyle while the lateral epicondyle is less distinct. Between the lateral condyle and trochlea is the extensor fossa.

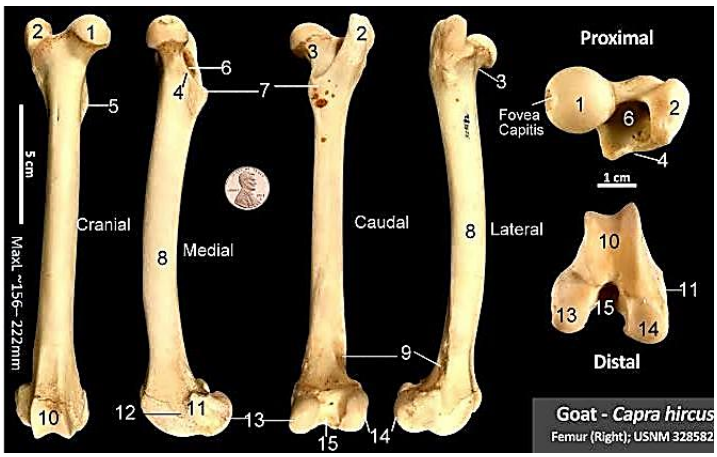


Figure 6.10: Caprine femur. 1, Head, 2, Greater trochanter, 3, Neck, 4, Trochanteric crest, 6, Trochanter fossa, 5, 7, Lesser trochanter, 8, Shaft, 9, Supracondyloid fossa, 10, Trochlea, 11, Lateral epicondyle, 11', Medial epicondyle, 12, Extensor fossa, 13, Medial condyle, 14, Lateral condyle, 15, Intercondyloid fossa.

INSTRUCTION:

Locate the Femur of the **Equine, porcine, canine and feline species** from the non-articulated bone collection to compare anatomical differences with that of the ruminants as described below:

Comparative anatomy

Equine (Horse):
The shaft is in general cylindrical. The lateral border is prominent in its upper part, and bears at the junction of its proximal and middle thirds the external or third trochanter (Trochanter tertius); this process is curved forward.

The fovea capitis is a deep notch. The great trochanter (Trochanter major) is divided into a cranial and caudal part. The trochanteric crest is vertically placed connecting the greater trochanter to the third trochanter.

Porcine (Pig):
The femur has a relatively wide and massive shaft, on which four surfaces might be recognized. The supracondyloid fossa is indistinct. The head is strongly curved, and is marked toward the inner side by a rather large depression. The neck is distinct. The external (third) trochanter is absent.

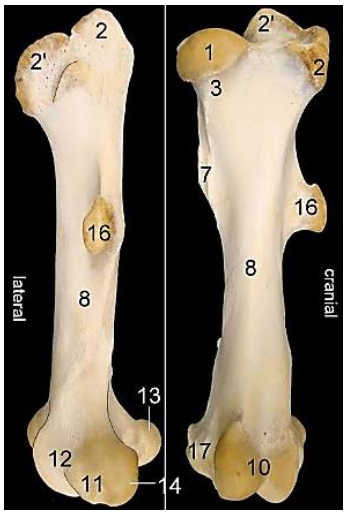


Figure 6.11: Equine femur. 1, Head, 2, Greater trochanter, 3, Neck, 7, Lesser trochanter, 8, Shaft, 10, Trochlea, 11, Lateral epicondyle, 12, Extensor fossa, 13, Medial condyle, 14, Lateral condyle, 16, Third trochanter, 17, Medial epicondyle.

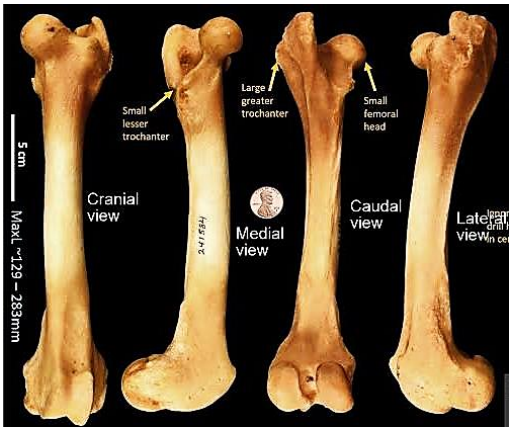


Figure 6.12: Porcine femur.

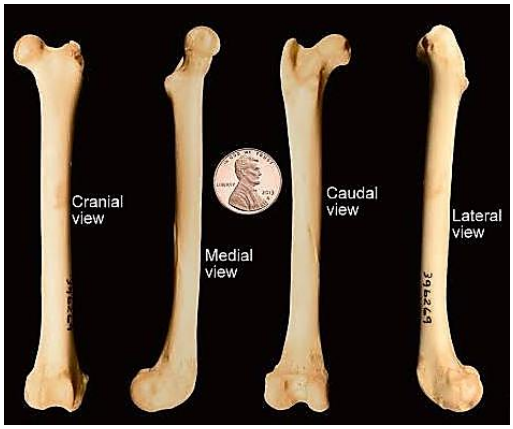


Figure 6.13: Feline femur.

Canine (Dog):

It is relatively longer and smoother. The shaft is more nearly cylindrical. The greater trochanter is small, the lesser trochanter is very small. The supracondyloid fossa is absent. Two facets are present on the caudal aspect of the condyles for articulation with sesamoid bones called fabellae.

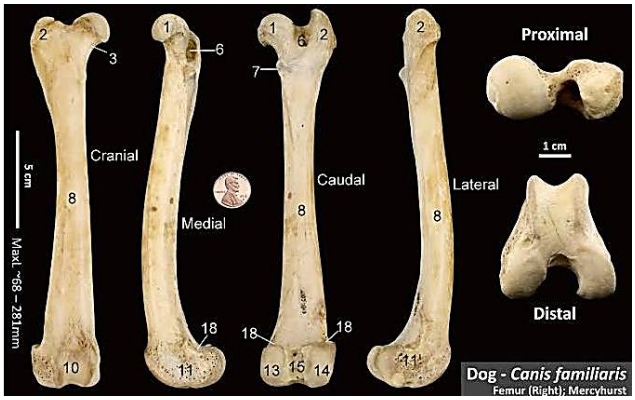


Figure 6.14: Canine femur. 1, Head, 2, Greater trochanter, 3, Neck, 4, Trochanteric crest, 6, Trochanter fossa, 5, 7, Lesser trochanter, 8, Shaft, 9, Supracondyloid fossa, 10, Trochlea, 11, Lateral epicondyle, 11', Medial epicondyle, 12, Extensor fossa, 13, Medial condyle, 14, Lateral condyle, 15, Intercondyloid fossa, 16, Fabella facet

Patella

This is a thick sesamoid bone which articulates with the trochlea of the femur. It presents for description two surfaces, two borders, a base and an apex. The cranial or free surface is strongly convex and very rough and irregular. The articular surface is convex from side to side. The borders, medial and lateral, converge to the apex distally. The base is convex and faces proximally.

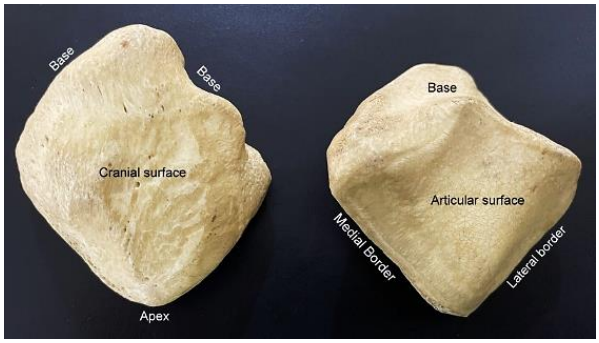
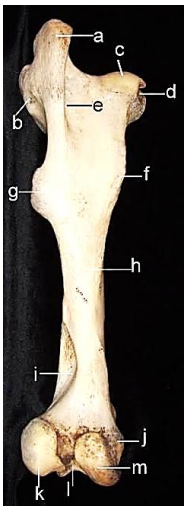


Figure 6.15: Equine Patella.

ACTIVITY:

Name the view _____ of the _____ bone of the _____species in the schematic presentation and label the numbered parts. Sketch and label the cranial and caudal views of the Bovine Patella.



a _____
b _____
c _____
d _____
e _____
f _____
g _____
h _____
i _____
j _____
k _____
l _____
m _____

Bovine Patella (Cranial)	Bovine Patella (Caudal)

Briefly describe the differences in the feline femur in the space provided. Also compare the features of the Pelvic bone in these species using + for presence and – for absence.

_____

_____

_____

_____

Features	Ox	Horse	Pig	Dog	Cat
Greater trochanter					
Lesser trochanter					
Trochanter tertius					
Oblique trochanteric crest					
Straight trochanteric crest					
Trochanteric fossa					
Supracondyloid fossa					
Fabella articular surface					
Condyle and Epicondyle					

Tibia and Fibula

The **Tibia** possesses a shaft (with three borders) and two extremities.

The **shaft or body** presents three surfaces and three borders. The medial surface is broad above and narrower below. The lateral surface is smooth and somewhat spiral. It is wide and concave in its upper part, below which it becomes narrower and slightly convex, and winds gradually to the front of the bone; near the distal end it widens a little, becomes flat, and faces forward. The caudal surface is marked by a rough popliteal line, which runs obliquely from the upper part of the lateral border to the middle of the medial border and few muscular lines. The nutrient foramen is situated on or near the popliteal line.

The cranial border is very prominent in its upper third forming the tibial crest below it is reduced to a rough line, which ends at a small elevation near the distal end of the bone.
The medial border is rounded in its upper half and a tubercle is found on this part. The lower part is a rough line on well-marked bones.
The lateral border is concave in its upper part.

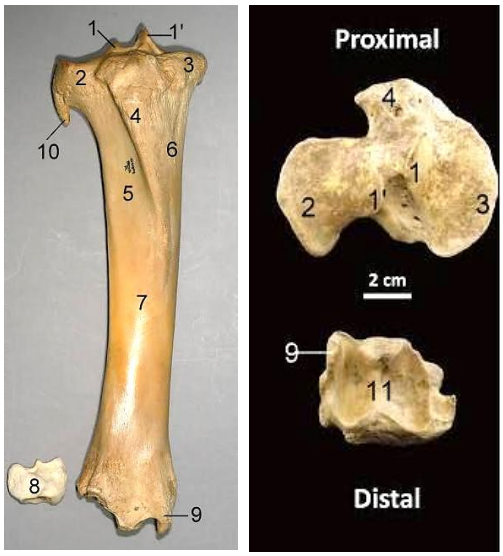


Figure 6.16: Bovine Tibio-fibula (Cranial, Proximal and distal view). 1, 1', Intercondyloid eminence (low and high part), 2, Lateral condyle, 3, Medial condyle, 4, Tibia tuberosity and crest, 5, Lateral surface, 6, Medial surface, 7, Shaft, 8, Lateral malleolus, 9, Medial malleolus, 10, Fibula, 11, distal articular surface.

The **proximal extremity** is large and three-sided. It bears two lateral eminences, the medial and lateral condyles. Each presents a somewhat saddle-shaped surface for articulation with the condyle of the femur and the semilunar cartilage. The spine or intercondyloid eminence is the central prominence, upon which the articular surfaces are continued; it consists of a high inner part and a lower outer part. On, before, and behind the spine are the cranial and caudal intercondyloid fossae for cartilage attachment. The condyles are separated behind by the deep popliteal notch. The lateral condyle has an overhanging outer margin, below which is a facet for articulation with the fibula. The large cranial eminence is the tuberosity of the tibia.

The **distal extremity** is much smaller than the proximal; it is quadrangular in form and larger medially than laterally. It presents an articular surface which is adapted to the trochlea of the tibial tarsal bone, and consists of two grooves separated by a ridge and bounded by the malleoli. The medial malleolus is more prominent is marked by a vertical groove for the

passage of the lateral extensor tendon. The lateral malleolus is a single bone articulated to the lateral aspect of the distal extremity.

The **Fibula** usually consists of two extremities only. The head is fused with the lateral condyle of the tibia and bears a short small blunt-pointed projection. This is less prominent in sheep and goat.

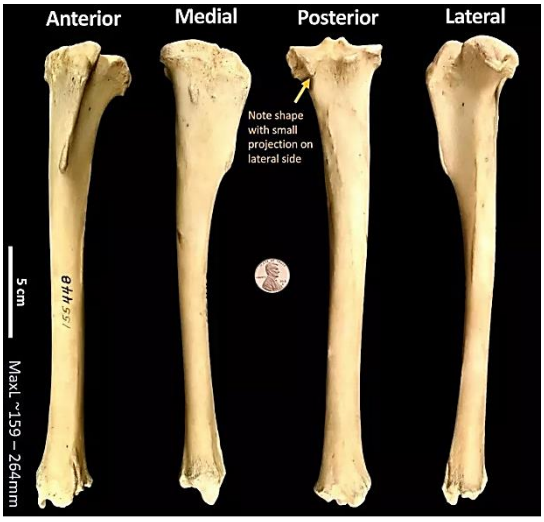


Figure 6.17: Ovine Tibia.

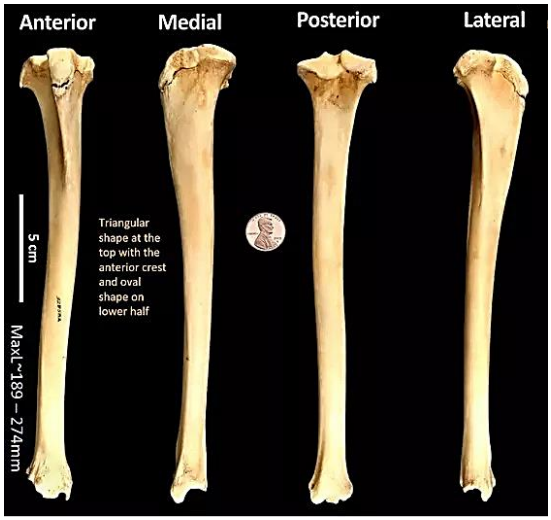


Figure 6.18: Caprine Tibia.

INSTRUCTION:

Locate the Tibia and Fibula of the **Equine, porcine, canine and feline species** from the non-articulated bone collection to compare anatomical differences with that of the ruminants as described below:



Figur 6.19: Equine Tibio-fibula bone (cranial view). 1'' Tibia tuberosity 2, Lateral condyle, 3, Medial condyle, 4, Tibia crest, 5, Lateral surface, 6, Medial surface, 7, Shaft, 8, Lateral malleolus, 9, Medial malleolus, 10, Fibula.

Comparative anatomy

Equine (Horse):

The caudal surface of the tibia is flattened, and is divided into two parts by the rough popliteal line, which runs obliquely from the upper part of the lateral border to the middle of the medial border. The triangular area above the line is occupied by the popliteus muscle, while the area below is marked by rough lines to which the deep flexor muscle of the digit is attached. The ridge and grooves of the

articular surface of the distal extremity are directed obliquely.

The fibula is a reduced long bone, situated along the Lateral border of the tibia. The shaft is a slender rod which forms the outer boundary of the interosseous space; it usually terminates below in a pointed end about one-half to two-thirds of the way down the lateral border of the tibia. N.B: This is usually absent in some breeds.

Porcine (Pig):

The shaft of the tibia is slightly curved, convex medially. The tuberosity is grooved in front, and a narrow sulcus separates it from the lateral condyle. The upper part of the crest is very prominent and curves outward. The distal end resembles in general that of the ox.

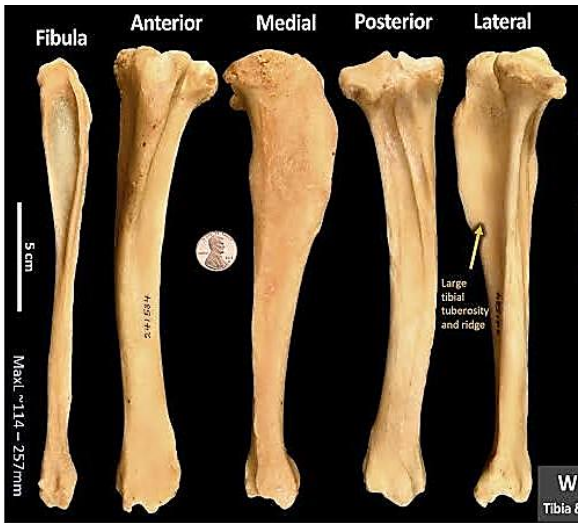


Figure 6.20: Porcine Tibia and fibula.

The fibula extends the entire length of the region, and is separated from the tibia by a wide interosseous space. The shaft is flattened from side to side; the proximal part is wide and deeply grooved while the lower part is narrower and thicker. The proximal end is flattened, grooved laterally, and articulates medially with the external condyle of the tibia. The distal end forms the lateral malleolus.

Canine (Dog):

Tibia is about the same length as the femur. The body forms a double curve, the proximal part is convex medially and the distal part laterally. The proximal third is prismatic, but compressed laterally and long craniocaudally with the remaining part almost regularly cylindrical. The cranial border is short but prominent. The tuberosity is not grooved. Facet for fibula is small and located on the caudolateral part of the lateral condyle.

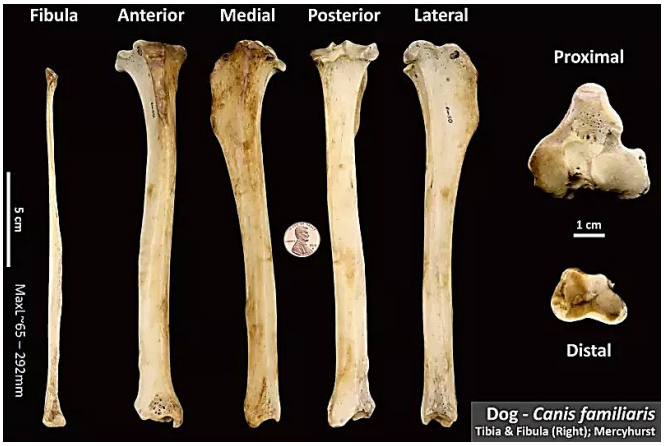


Figure 6.21: Canine Tibia and fibula.

The Fibula extends the entire length of the region. It is slender, somewhat twisted and enlarged at either end. The proximal part of the body is separated from the tibia by a considerable interosseous space but the distal part is flattered and closely applied to the tibia.

ACTIVITY:

Pick up the feline tibia and fibula, confirm its features with figure 6.22 and describe it in the spaces provided.

_____

_____

_____

_____

_____

_____

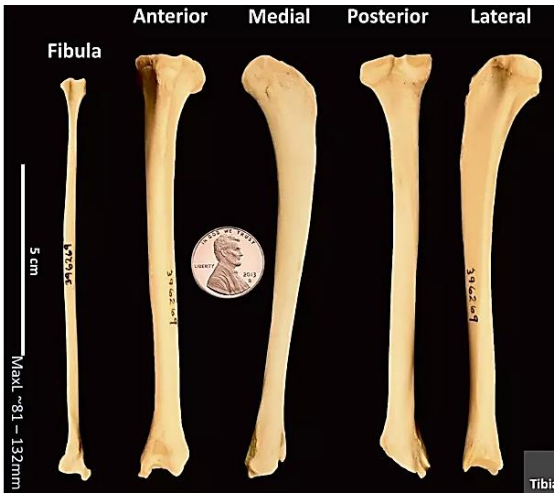


Figure 6.22: Feline Tibia and fibula bone.

Sketch and label the caudal views of the Bovine and Equine Tibio-fibula bone.
Compare the features of the Tibia and fibula in these species using + for presence and – for absence.

Bovine Tibio-fibula (Caudal view)	Equine Tibio-fibula (Caudal view)

Features	Ox	Horse	Pig	Dog	Cat
High intercondyloid eminence					
Tibia tuberosity					
Muscular lines					
Polpliteal line					
Incomplete fibula					
Complete fibula					
Comma shaped fibula					
Detached lateral malleolus					

Tarsal

The lower terminal part of the hind limb is called the *Pes* and it includes the tarsus (hock), metatarsus and digits.

The tarsus of ruminants consists of five pieces of short bones arranged in two rows.
The proximal row consists of two bones, the talus (tibial tarsal bone) and calcaneus (fibular tarsal bone): the former is situated at the tibial (medial) side and the latter situated at the fibular (lateral) side.

The distal row consists of three bones i.e. first, second and third tarsal fused and central and fourth tarsal fused.

Talus (Tibial tarsal bone):
It is relatively long, narrow and flattened dorsoplantarly. It bears a trochlea at either end. The groove and ridges of the proximal trochlea are almost sagittal; the lateral ridge is wider and articulates with both tibia and fibula. The distal trochlea consists of two condyles separated by a groove and articulates with the fused central and fourth tarsal. The planter surface bears a large oval facet for articulation with the calcaneus and on the lateral surface, two facets for calcaneus. The medial surface bears a tuberosity proximally and is flattened distally.

Calcaneus (fibular tarsal bone):
This is the largest bone of the hock. It is elongated and slender. Its proximal end is enlarged to form the calcaneal tuber or point of the hock marked plantarly by a wide shallow groove coated with cartilage in the fresh state. The distal part of the body compressed laterally and bears a projection dorsally the sustentaculum (sustentacular talli) which articulates with the lateral malleolus.

Central and fourth tarsal (centroquartal bone):
The fused central and fourth tarsal bone extends across the entire width of the tarsus articulating with all of the other bones. Its proximal surface is molded in great part on the distal trochlea of the talus with its medial part rising high above the rest plantarly. A narrow undulating surface is located laterally for articulation with the distal end of the calcaneus. The plantar surface bears two tuberosities, of which the lateral is rounded and the medial more prominent and narrower.

First tarsal bone:
This bone is small and quadrilateral and articulates with the centroquartal proximally, metatarsus distally and the fused second and third dorsally.

Second and third tarsal bone:

The second and third tarsal bones are fused to form a rhomboid piece which has a concave convex proximal surface that articulates with the centroquartal and an undulating distal surface which rests on the metatarsus. The lateral surface bears a small facet dorsally for the centroquartal and a small one on the planter surface for the first tarsal bone.

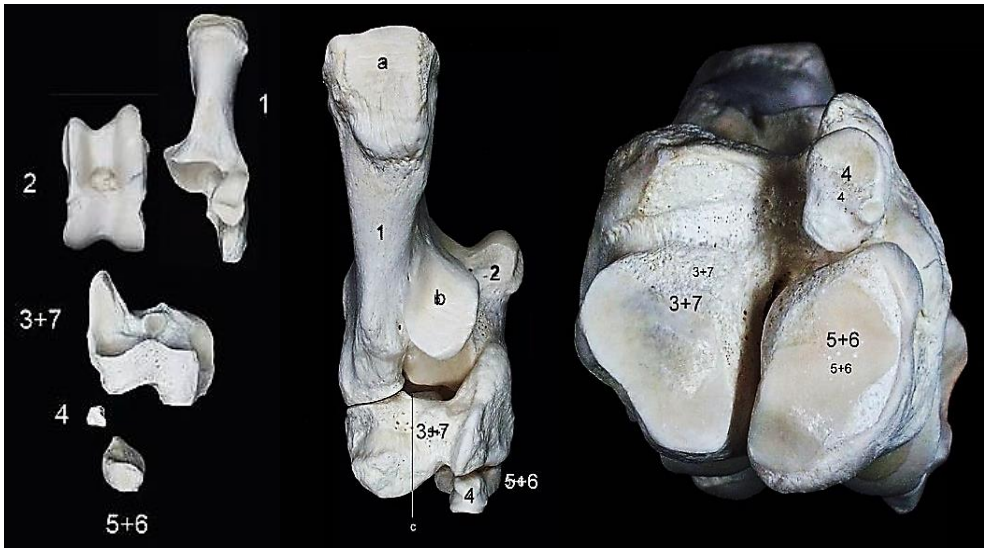
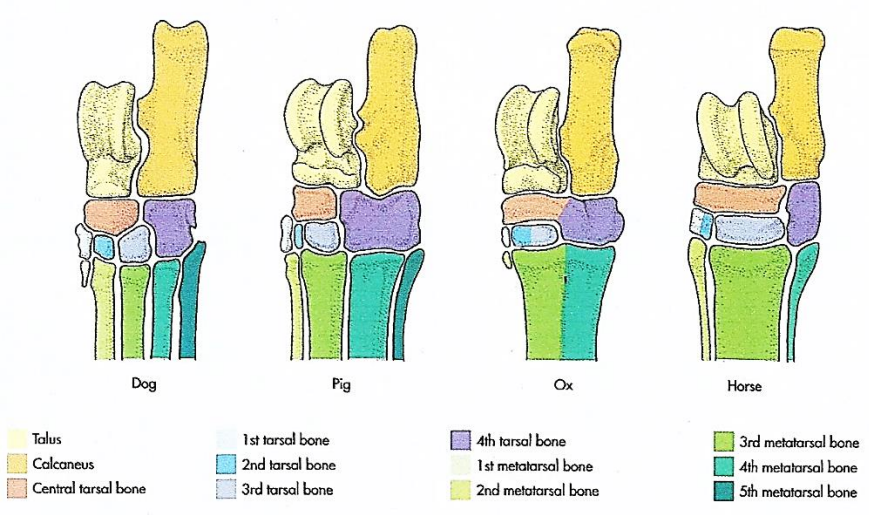


Figure 6.23: Bovine tarsals (Cranial, caudal and ventral views). 1, Calcaneus, 2, Talus, 3+7, Centroquartal, 4, First tarsal, 5+6, Second and third tarsal, a, Calcaneal tuber, b, Sustentacular talli

Comparative anatomy

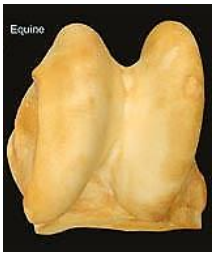


ACTIVITY:

Locate the above mentioned tarsal bones of the **Equine, Porcine, Canine** and **Feline species** from the non-articulated bone collection to compare anatomical differences in their features with that of the ruminants using + for presence and – for absence in the table below.

Tarsal bones	**Ox**	**Sheep and Goat**	**Horse**	**Pig**	**Dog**	**Cat**
Talus (1 trochlea)						
Talus (2 trochlea)						
Calcaneus						
Central tarsal						
First tarsal						
Second tarsal						
Third tarsal						
Fourth tarsal						
First & second fused						
Second & third fused						
Centroquartal						
Total number						

Locate the Talus of the Porcine, Canine and Feline, Sketch in the space provided below.

				
Equine talus	Bovine talus	Porcine talus	Canine talus	Feline talus

Metatarsal

The metatarsal has similar features to a large extent with that of the metacarpal. However, its length is longer and its proximal articular surface appears different from that of the metacarpal due to the shape of the tarsal bones articulating with this surface.

Digits

The Digits of the hind limb closely resemble those of the forelimb. That is, the phalanges have the same general arrangement, but present some important differences in length, width and direction of inclination.

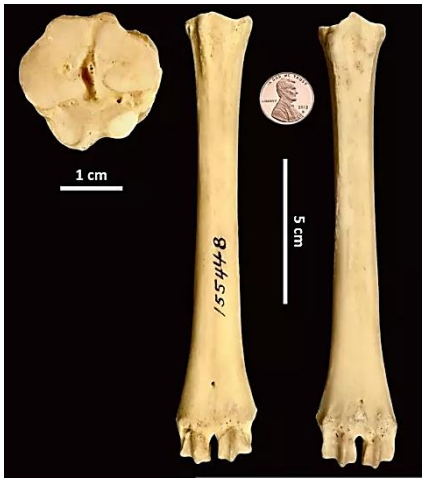


Figure 6.24: Sheep Metatarsal (Proximal, cranial dorsal and plantar views)

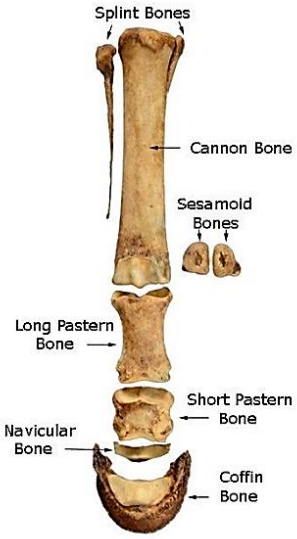


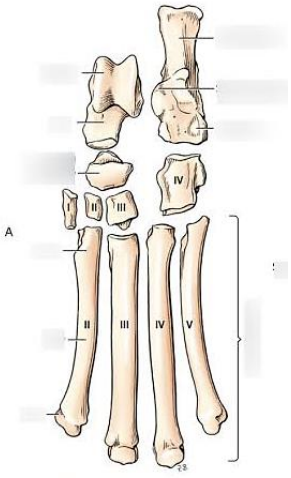
Figure 6.25: Equine metatarsals and digit.

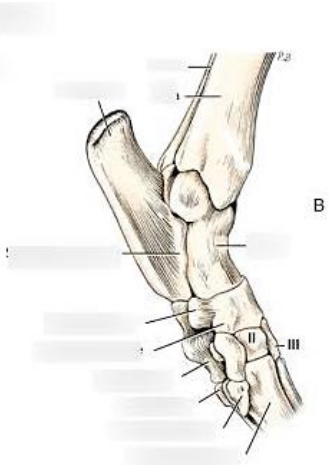


Figure 6.26: Porcine pes

ACTIVITY

Name the views _____ of the _____ bone of the _____ species in the schematic presentation and label the pointed parts.





SECTION B: **SYNDESMOLOGY**

Chapter 7: Joints/Articulations

Chapter 8: Articulations of the Skull

Chapter 9: Articulations of the Vertebral column

Chapter 10: Articulations of the Thorax

Chapter 11: Articulations of the Fore limb

Chapter 12: Articulations of the Hind limb

Chapter 7: **JOINTS**

A joint or articulation is formed by the union of two or more bones or cartilages by other tissue. Bone is the fundamental part of most joints; in some cases a bone and a cartilage, or two cartilages, form a joint. The uniting medium is chiefly fibrous tissue or cartilage, or a mixture of these.

Classification of Joints

Joints may be classified according to the following:

(a) Nature of uniting medium
- Fibrous joints
- Cartilaginous joints
- Synovial joints

(b) Nature of articular surfaces
- Serrated joints
- Squamous joints
- Harmonia joints
- Ball and socket joints
- Condylar (Ellipsoidal or saddle) joints

(c) Mode or nature of movement
- Synarthroses
- Amphiarthroses
- Diarthroses

Based on nature of uniting medium

FIBROUS JOINT

- They are united by fibrous tissue
- They lack joint cavities
- They are immovable joints that result in synostosis.

Classes of this joint include:

1. Sutures

This term is applied to those joints in the skull in which the adjacent bones are closely united by fibrous tissue. In many cases the edges of the bones have irregular interlocking margins, forming serrated sutures e.g Frontal suture. In others the edges are beveled and overlap forming squamous sutures, e. g Parieto-temporal suture. If the edges are plane or slightly roughened, they form harmonia sutures e.g Nasal suture.

2. Syndesmosis

This term is applied for joints like the metacarpal shafts, costal cartilages, radio-ulna, tibio-fibula. When some joints in this class undergo ossification with advancing age the process is known as a synostosis.

3. Gomphosis

This term is applied to the implantation of the teeth in the alveoli.

CARTILAGENOUS JOINT

- They are united by cartilage (hyaline or fibrocartilage)
- Also temporal and ossifies later in life

Classes of this joint include:

1. Synchondrosis

This term is applied to the union of bones held by hyaline cartilage such as the joint between the Basioccipital and basisphenoid bones, the joint between the diaphysis and epiphysis of long bones.

2. Symphysis

This term is applied to the union of bones held by fibrocartilage such as the joint between the two halves of the mandible, the joint between the Os coxae.

SYNOVIAL JOINT

These joints are united by both fibrous tissue and cartilage. They possess the following components

- Articular cartilages:

This is a persistent unossified layer of cartilage derived from the cartilaginous precursor of the bone. They cover the articular surfaces of bone to reduce friction and concussion.

- Articular capsule (Joint capsule):

This is a tube in its simplest form, the ends of which are attached around the articulating surface. It is composed of an external fibrous layer and an internal synovial layer or membrane.

The *fibrous layer* sometimes called capsular ligament is attached either close to the margin of the articulating surfaces or at variable distance from them. Its thickness varies greatly in different situations: in certain places it is extremely thick, and sometimes cartilage or bone develops in it: in other places it is practically absent, the capsule then consists only of synovial membrane.

The synovial layer lines the joint cavity but does not cover the articular cartilage but blends with the periosteum. It is a thin membrane and is richly supplied by close networks of vessels and nerves. It frequently forms folds and villi which project into the cavity of the joint. The synovial membrane secretes fluid called synovia which imbricates the joint. It also serves to transport nutrient material to the hyaline articular cartilage.

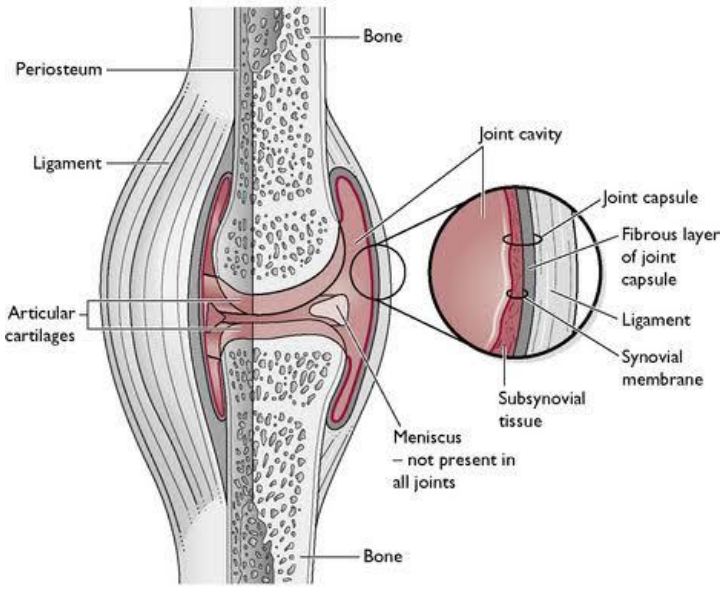


Figure 7.0: Schematic presentation of a synovial joint

- Ligaments:

These are strong bands or membranes usually composed of white fibrous tissue, which binds the bones together. They are pliable but practically inelastic except for the nuchal ligament which is composed of elastic tissue.

When found within the joints, they are called Intra-articular (intracapsular) ligaments.

While those found outside the joint capsule are called Peri-articular (extracapsular) ligaments.

Peri-articular ligaments are called the following depending on their location:

Collateral ligaments – when located on the medial and lateral sides of the joint
Annular ligaments – when surrounding the joints
Interosseous ligaments – when connecting opposing surfaces of bone

- Articular discs or Menisci:

These are plates of fibrocartilage or dense fibrous tissue placed between opposite articular cartilages dividing the joint cavity partially or completely into two compartments. They render certain surfaces congruent thereby allowing greater range or variety of movement and diminish concussion.

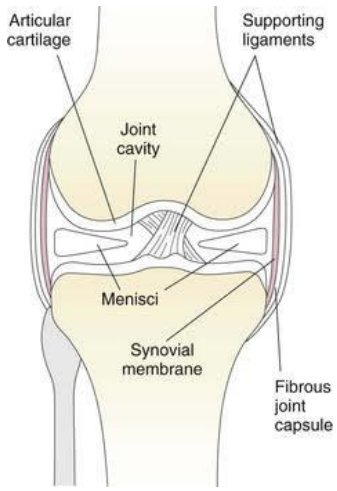


Figure 7.1: Schematic presentation of a synovial joint.

- Marginal cartilage:

A ring of fibrocartilage that encircles the rim of the articular cavity. It enlarges the cavity and tends to prevent fracture of the margin

Classes of this joint include:

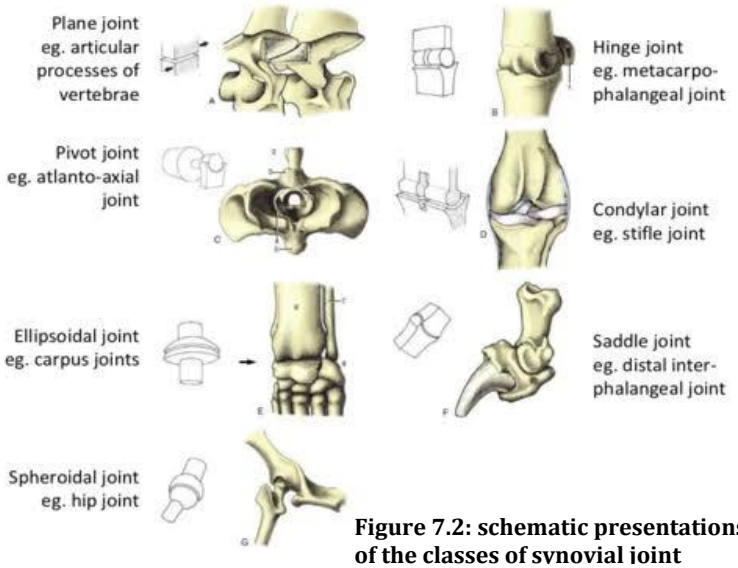


Figure 7.2: schematic presentations of the classes of synovial joint

Based on nature of articular surfaces

Serrated joints – The articular surfaces have irregular interlocking margins e.g Frontal suture

Squamous joints – The articular surfaces are beveled and overlapping e.g Parieto-temporal suture

Harmonia joints – The articular surfaces are slightly roughened or plane e.g Nasal suture

Ball and socket joints – One articular surface is ball like while the other may be concave or socket like e.g Hip joint

Ellipsoidal or saddle joints – One articular surface is convex while the other is concave. It takes the shape of a saddle or an ellipsoid e.g Metacapophalangeal, stifle, interphalangeal.

Based on nature of movement

SYNARTHROSES

- Joints in this group are often termed fixed or immovable joints.
- There is no joint cavity.
- Many of these joints are temporary, the uniting medium being invaded by the process of ossification, with a resulting ankylosis or synostosis
- Classes include: Suture, Synchondrosis and Gomphosis

AMPHIARTHROSES

- These joints share some characters with both synarthroses and diarthroses.
- They are slightly movable and determined by the shape of the joint surfaces and the amount and pliability of the uniting medium.
- These joints are all medial in position, and are best illustrated by the joints between the bodies of the vertebrae.
- There is usually no joint cavity, but in certain situations a rudimentary one exists.
- Classes include: Symphysis and Syndesmosis

DIARTHROSES

- These joints are freely movable

Classes of these joints include:

1. Ginglymus: These joints move in a sagittal plane only. The two movements of this joint are flexion and extension as seen with the elbow (Humero-radial) joint.

2. Arthroidal: These have only slight gliding movement between articular facets as seen in joints between articular processes of cervical vertebrae.
3. Trochoid: Movement occurs in one axis as seen in Atlanto axial joint.
4. Enarthroidal: Movements in these joints are extensive and varied as seen in the coxo-femoral joint.

Joint Movements

Flexion: Movement in sagittal plane which decreases the angle between bones

Extension: Movement in sagittal plane which increases the angle between bones

Hyperextension: Movement in sagittal plane which makes an angle of more than 180 degrees

Rotation: Movement around longitudinal axis

Abduction: Movement away from the median plane

Adduction: Movement towards the median plane

Circumduction: Distal end of the bone describes a circle or a segment of circle

Pronation: Forearm or manus is positioned such that volar faces downwards or backwards

Supination: Volar face of manus faces upwards or forward

Gliding: Movement of one bony surface on another without changes in the angle between the bones and without rotation but angular and rotatory movements generally occur.

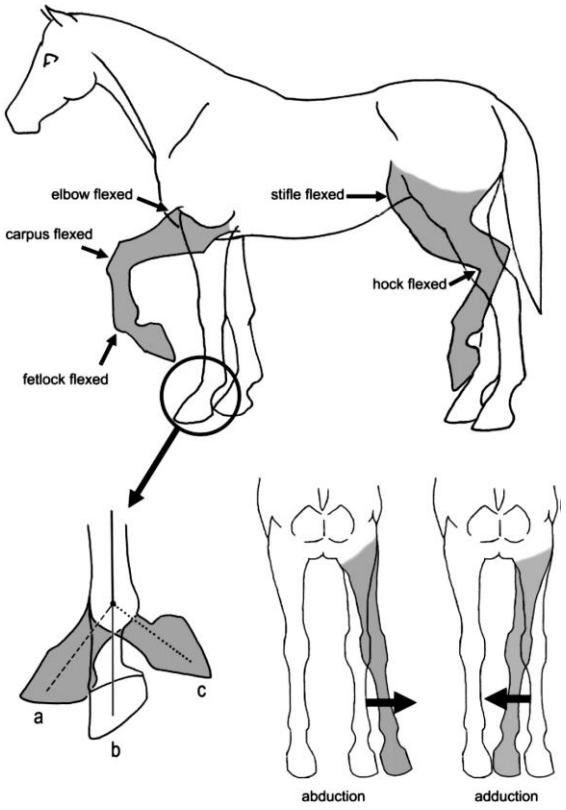


Figure 7.3: Schematic presentation of some joint movement in horses.

Chapter 8: **ARTICULATIONS OF THE SKULL**

INSTRUCTION:

Pick up the skull of any given species from the bone collections or examine the skull of an articulated skeleton and identify the following articulations/joints:

Temporo-mandibular articulation:

A joint formed between the ramus of the mandible and the squamous part of the temporal bone on either side. The articular surfaces are the articular tubercle, mandibular fossa of the squamous part of the temporal bone and the condyloid process of the Mandible.

An articular disc is placed between the joint surfaces making them congruent and its circumference is attached to the joint capsule dividing the joint cavity into upper and lower compartments.

The joint capsule is strong and tight and reinforced by two ligaments namely: lateral ligament and caudal ligament. N:B Caudal ligament is absent in pig and dog.

The movement is gliding and rotation.



Figure 8.0: Temporomandibular articulation, lateral view

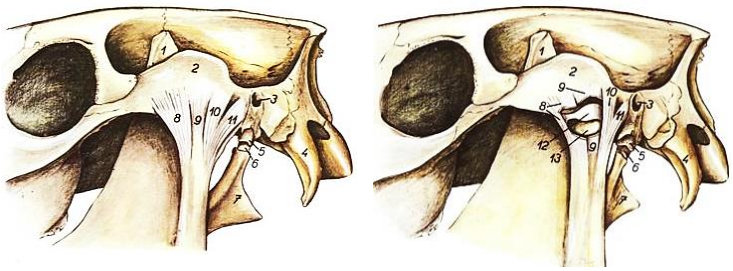


Figure 8.1 Schematic presentation of the equine temporomandibular articulation, lateral view. 1, Coronoid process of mandible; 2, Zygomatic process of temporal bone; 3, External acoustic meatus; 4, Paracondyloid process; 5, Styloid process; 6, Tympanohyoid; 7, Stylohyoid; 8, 9, Lateral ligament; 10, 11, Caudal ligament; 12, Articular disc; 13, Mandibular condyle.

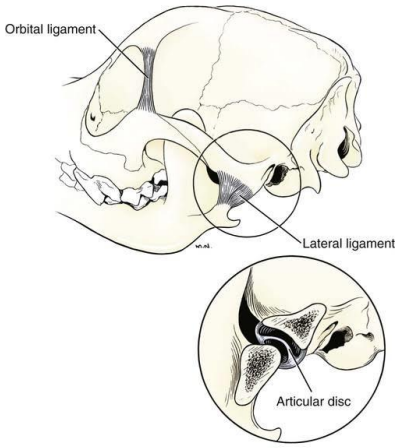


Figure 8.2: Schematic presentation of the canine temporomandibular joint

Hyoid Articulations

The *temporohyoid articulation* is a synchondrosis in which the articular angle of the dorsal end of the stylohyoid bone is attached by a short bar of cartilage to the styloid process of the petrous part of temporal bone. The chief movement is flexion and extension.

A synchondrosis is formed by the junction of the ventral extremity of the stylohyoid with the dorsal end of the ceratohyoid bone. They are united by a very short piece of cartilage in which there is usually a small nodule of bone in the young subject. This nodule, the epihyoid is usually fused with stylohyoid in the adult. Chief movement here is flexion and extension, the angle between the stylohyoid and ceratohyoid being increased or diminished.

A synovial joint is formed by the junction of each ceratohyoid with the basihyoid. The ceratohyoid has a concave facet which articulates with the convex facet on either end of the dorsal surface of the basihyoid. The movement is chiefly flexion and extension.

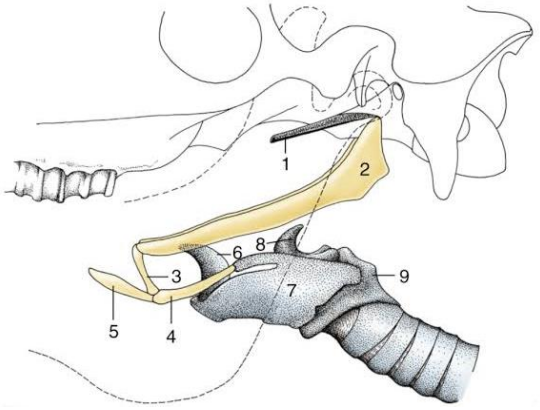


Figure 8.3: Schematic presentation of Equine hyoid articulation.

Principal synchondroses:

The joint between basilar part of the occipital bone and body of basisphenoid (spheno-occipital).
The joint between the presphenoid and basisphenoid (inter sphenoid).
The joint between the parts of the occipital bone (Squamolateral, basilateral and intraoccipital).

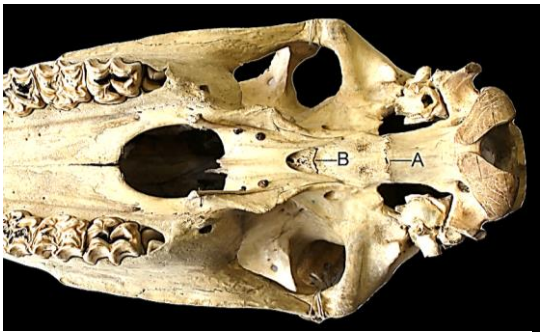


Figure 8.4: Equine skull (ventral view) showing A-Spheno-occipital synchondrosis, B-Intersphenoid synchondrosis.



Figure 8.5: Occipital synchondrosis

Gomphosis:

A joint formed by implantation of the teeth to the alveoli.

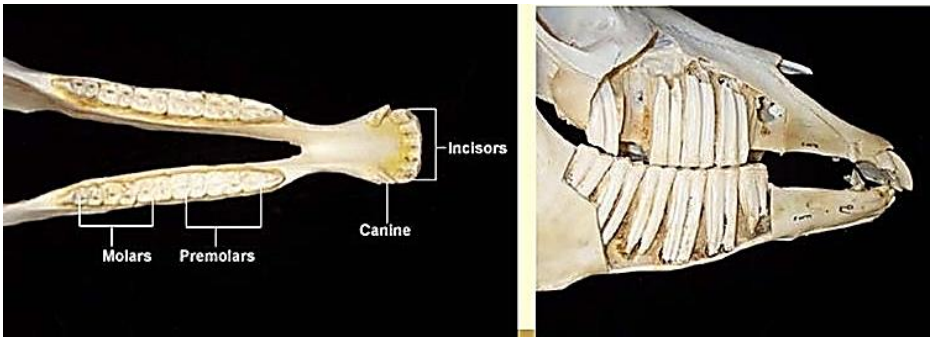


Figure 8.6: Gomphosis

Sutures:

Most bones of the skull are united with adjacent bones via fibrous tissue. Most of these joints are temporal and are obliterated at various periods during development and growth. Their importance lies in the fact that so long as they persist continuous growth is possible. They are usually designated according to the bone which enter into their formation e.g. sphenosquamousal suture, frontonasal suture, Parietofrontal suture, interfrontal suture, Nasomaxillary suture etc. There is practically no movement in these joints.

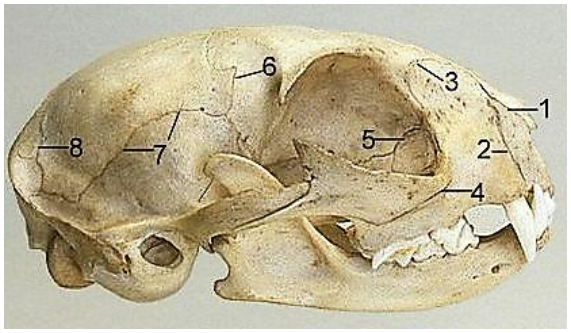


Figure 8.7: Feline skull (Lateral view) showing sutures.
1, Naso-incisive suture, 2, Inciso-maxillary suture, 3, Fronto-maxillary suture, 4, Malo-maxillary suture, 5, Fronto-lacrimal suture, 6, Parieto-frontal suture, 7, Parietotemporal suture, 8, OccipitoParietal suture.

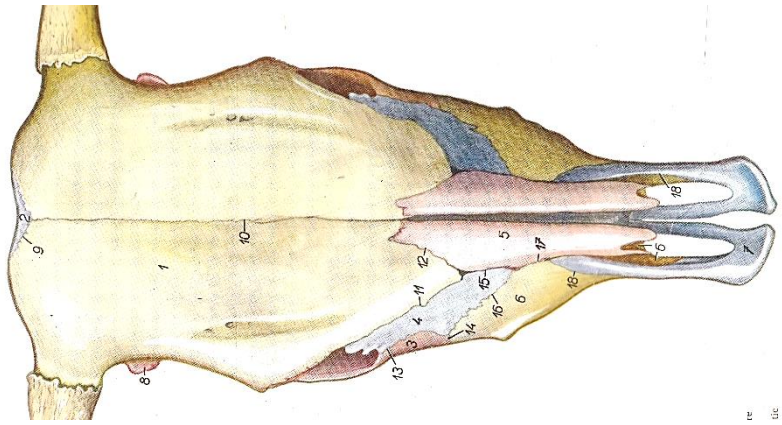


Figure 8.8: Bovine skull, dorsal view showing sutures.
9, Interparieto-frontal suture, 10, Interfrontal suture, 11, Fronto-lacrimal suture, 12, Fronto-nasal suture, 13, Lacrimo-malar suture, 14, Malo-maxillary suture, 15, Lacrimo-frontal suture, 16, Lacrimo-maxillary, 17, Naso-maxillary suture, 18, Maxillo-incisive suture.

ACTIVITY: Fill in the table below with the appropriate

s/n	Joint	Classification			Articular surfaces	Other structures	Movement
		Nature of uniting medium	Nature of articular surface	Nature of movement			
1.	Temporo-mandibular						
2.	Stylo-ceratohyoid						
3.	Cerato-basihyoid						
4.	Intersphenoid synchondrosis						
5.	Gomphosis						
6,	Lacrimomaxillary suture						
7.	Interfrontal suture						
8.	Nasoincissive suture						

Chapter 9: **ARTICULATIONS OF THE VERTEBRAE**

INSTRUCTION:

Examine the vertebral column of the bovine, ovine and caprine articulated skeleton and identify the following articulations/joints:

Intercentral articulation



Figure 9.0: Intercentral and interneural articulation

These are slightly movable joints, formed by the bodies of adjacent vertebrae.
The articular surfaces consist of a cavity on the caudal end of the body of the cranial vertebra, and a corresponding convexity of the cranial end of the succeeding vertebra.

The uniting medium is the fibrocartilagenous intervertebral disc which occupies the space between adjacent vertebrae, to which it is intimately attached. The discs are thinnest in the middle of the thoracic region, thicker in the cervical and lumber regions and thickest in the caudal region. Each consists of a peripheral fibrous ring and a soft central pulpy nucleus.

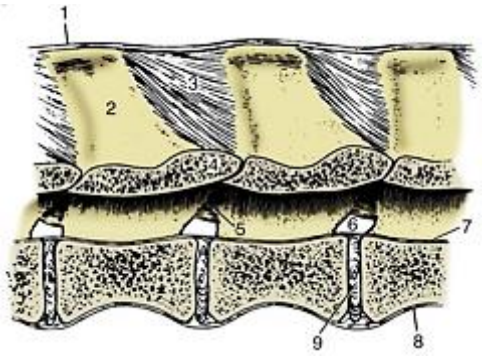


Figure 9.1 Schematic presentation of Intercentral and interneural articulations, lateral view. 1, Supraspinous ligament; 2, Spinous process; 3, Interspinous ligament; 4, Arch of vertebrae; 5, ligament flava; 6, Intervertebral foramen; 7, dorsal longitudinal ligament; 8, Ventral longitudinal ligament; 9, Intervertebral disc.

Two ligaments are associated with the bodies of the vertebrae namely:

Ventral longitudinal ligament - lies on the ventral surface of the bodies of the vertebrae and the intervertebral discs, to which it is firmly attached.

Dorsal longitudinal ligament - This lies on the floor of the vertebral canal from axis to the sacrum. It is narrow over the middles of the vertebral bodies and widens over the intervertebral discs to which it is firmly attached.

Interneural articulation

Each typical vertebra presents two pairs of articular processes, which form plane synovial joints with the two adjacent vertebrae. The joint capsule is strong and ample in the cervical region in conformity with the large size and greater mobility of these joints in the neck. In the thoracic and lumbar regions the capsule is small and close.

Ligaments associated with these joints are:

Ligament flava - This connects the arches of adjacent vertebrae.

Nuchal Ligament – An elastic apparatus whose principal function is to assist the extensor muscles of the head and neck. It extends from the occipital bone to the withers, where it is directly continuous with the supraspinous ligament. It consists of two parts namely: Funicular and Lamellar.

The funicular part arises from the occipital and is inserted into the summits of the vertebral spines at the withers.
The lamellar part is thick, and consists of cranial and caudal parts. The cranial part is double while the caudal part is single.

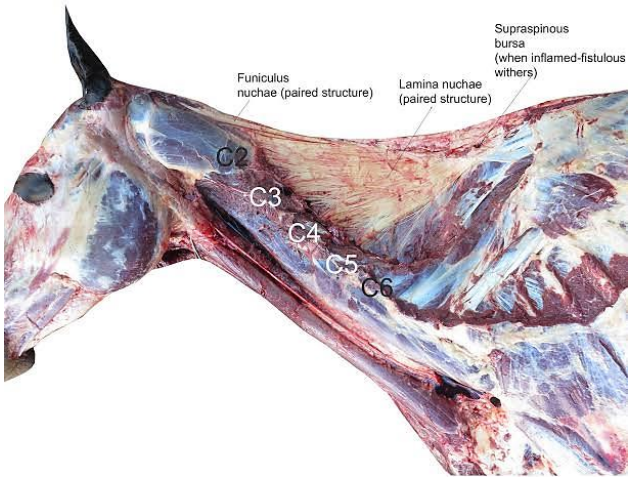


Figure 9.2: Equine neck muscles showing the nuchal ligament and its parts.

Supraspinous ligament - This extends medially from the level of the withers to the sacrum. It consists of a strong cord of white fibrous tissue attached to the summits of the vertebral spines.
Interspinous ligament - This extends between the spines of contiguous vertebrae
Intertransverse ligaments - These connect adjacent transverse processes in the lumbar region.

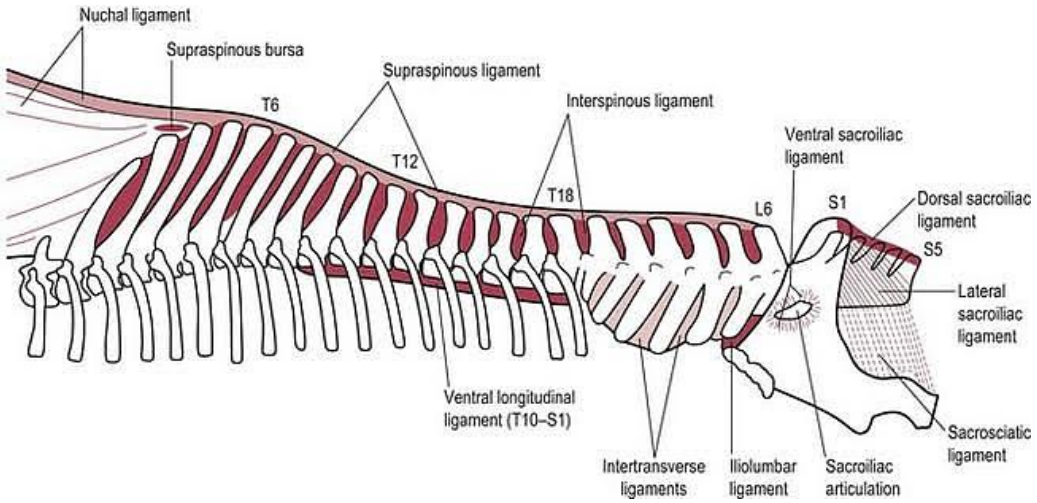


Figure 9.3: Schematic presentation of articulations and some ligaments of the vertebral column

Atlanto-occipital articulation

A synovial joint with articular surfaces consisting of two deep cavities on the Atlas and the corresponding condyles of the occipital bone. The movements are chiefly flexion and extension. A small amount of lateral oblique movement is possible.

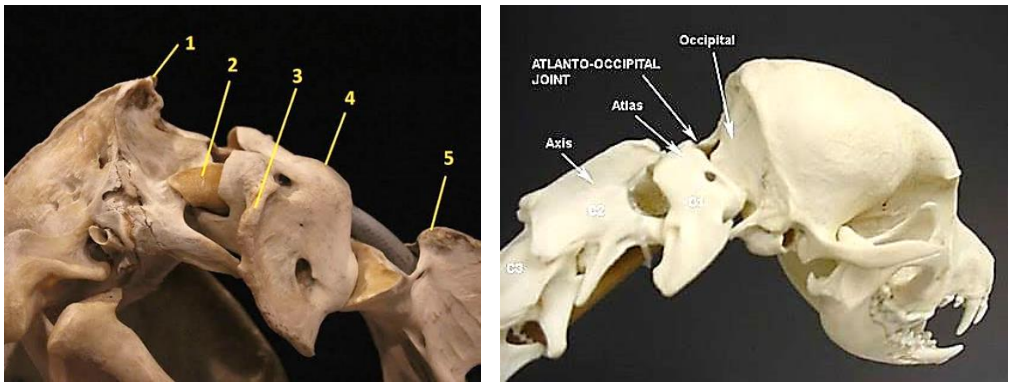


Figure 9.4: Atlanto-axial articulation in equine and canine species (lateral view)

Atlanto-axial articulation

A Trochoid (pivot) joint with two articular surfaces on the lateral masses of the atlas which are somewhat saddle-shaped facets separated by a wide notch dorsally and a narrow one ventrally and on the axis are reciprocal saddle – shaped surfaces which extend upon the dens and are confluent on its ventral aspect. The joint capsule surrounds the edges of the joint. Movement in this joint is rotation. The joint capsule is reinforced by ligaments namely:

The interspinous (Dorsal atlanto-axial) ligaments consisting of two elastic bands extend from the dorsal arch of the atlas to the spine of the axis.

The longitudinal ligament is short, very strong and somewhat fan-shaped. It extends from the rough concave surface of the dens, widens cranially, and is attached to the transverse rough area on the inner surface of the ventral arch of the atlas.

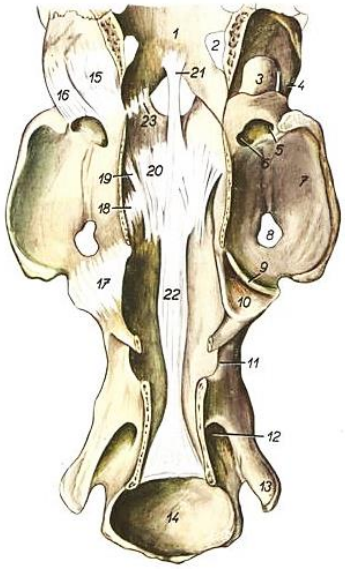


Figure 9.5 Atlantoaxial articulation with spinous processes removed to show ligaments. 14, Caudal extremity of axis; 15, Capsule of atlanto-occipital articulation; 16, Lateral ligament; 17, 18, Capsule of atlanto axial articulation; 19, Lateral alar ligament; 20, medial alar ligament; 21, Ligament of dentis; 22, dorsal longitudinal ligament.



Figure 9.6: Canine Atlanto-axial articulation, dorsocranial view.

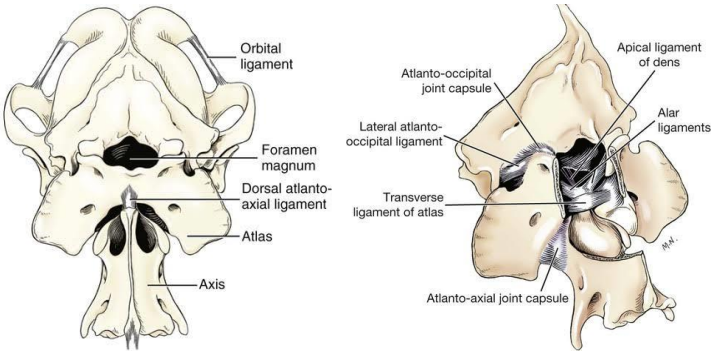


Figure 9.7: Canine Atlanto-occipital and Atlanto-axial articulation showing associated ligaments (Dorsal and dorsolateral views).

Sacral articulations

The bodies, arches and spines of the sacral vertebrae form joints which resemble somewhat those in the caudal part of the lumbar region. These joints are invaded by the process of ossification early.

Caudal articulations

The caudal vertebrae are united by relatively thick biconcave intervertebral discs. Special ligaments are not present, but there is a continuous sheath of fibrous tissue. The movement in this region is extensive and varied.

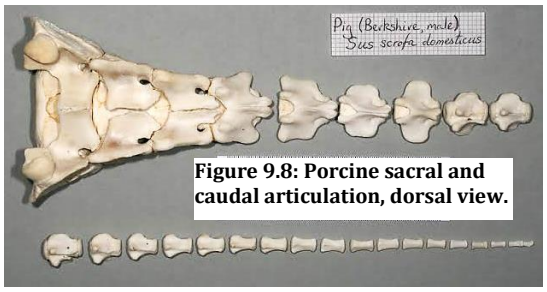


Figure 9.8: Porcine sacral and caudal articulation, dorsal view.

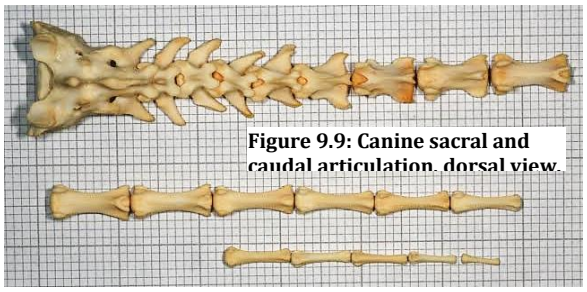


Figure 9.9: Canine sacral and caudal articulation, dorsal view.

Movement of the vertebral column

The movements of the spine, exclusive of those at the atlantoaxial joint are dorsal, ventral, and lateral flexion, and rotation. The movements are freest in the cervical and caudal regions. Rotation is extremely limited in the thoracic and lumbar regions.

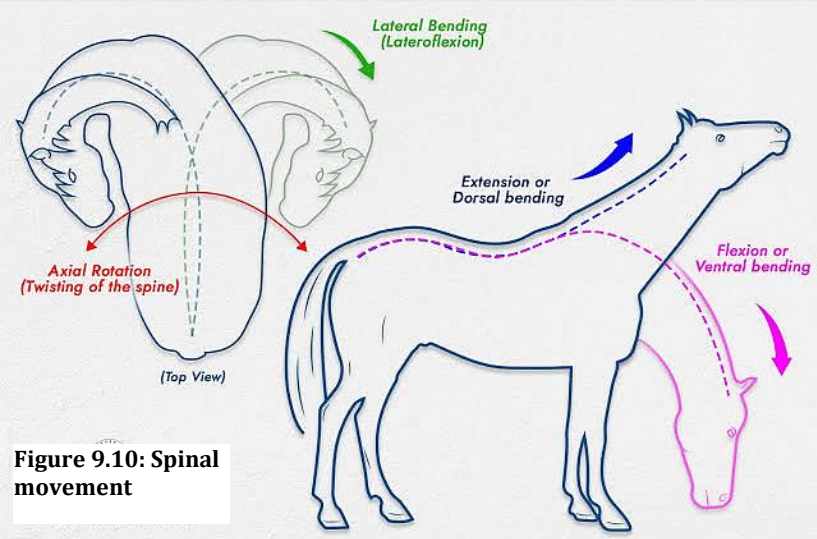


Figure 9.10: Spinal movement

Comparative anatomy

Equine (Horse):

The lamellar part of the nuchal ligament consists of two laminae separated medially by a layer of loose connective tissue. Each lamina is formed of digitations which arise from the 2nd and 3rd thoracic spine and from the funicular part. The digitations are directed ventrally and cranially, and end on spines of the cervical vertebrae except the 1st and last.

Intertransverse articulation (a synovial joint) is formed by the transverse processes of the 5th and 6th lumbar vertebrae and between the 6th lumber and wings of the sacrum. A similar joint between the 4th and 5th lumber processes may also be present. The articular surfaces have an elongated oval form, the cranial one being concave and caudal one convex.

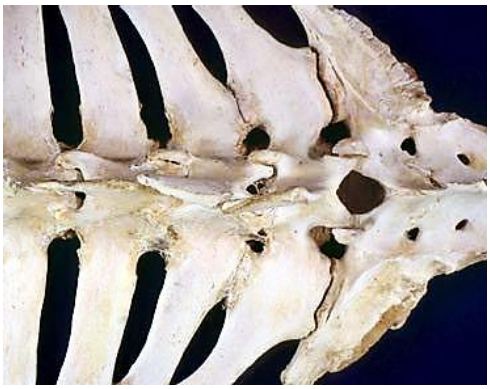


Figure 9.11: Intertransverse articulation

Porcine (Pig):

The nuchal ligament is represented by fibrous raphae and thin layers of elastic tissue which extend between the cervical spines. The atlanto-occipital and atlanto-axial joints resemble those of the dog. The interspinous ligaments of the neck are elastic.

Canine (Dog):

The nuchal ligament consists of a small fibrous band which extends from the spine of the axis to the cranial thoracic spines; it may be regarded as a mere fibrous raphe between the right and left muscles. There are interspinous muscles instead of ligaments in the neck.

There are three ligaments in connection with the odontoid process. The two alar ligaments arise on either side of the odontoid process, diverge, and end on either side of the foramen magnum. The transverse ligament of the atlas stretches across the dorsal surface of the odontoid process and binds it down on the ventral arch of the atlas, a bursa being interposed. The two capsules of the atlanto-occipital joint communicate with each other and usually with the capsule of the atlanto-axial joint also.

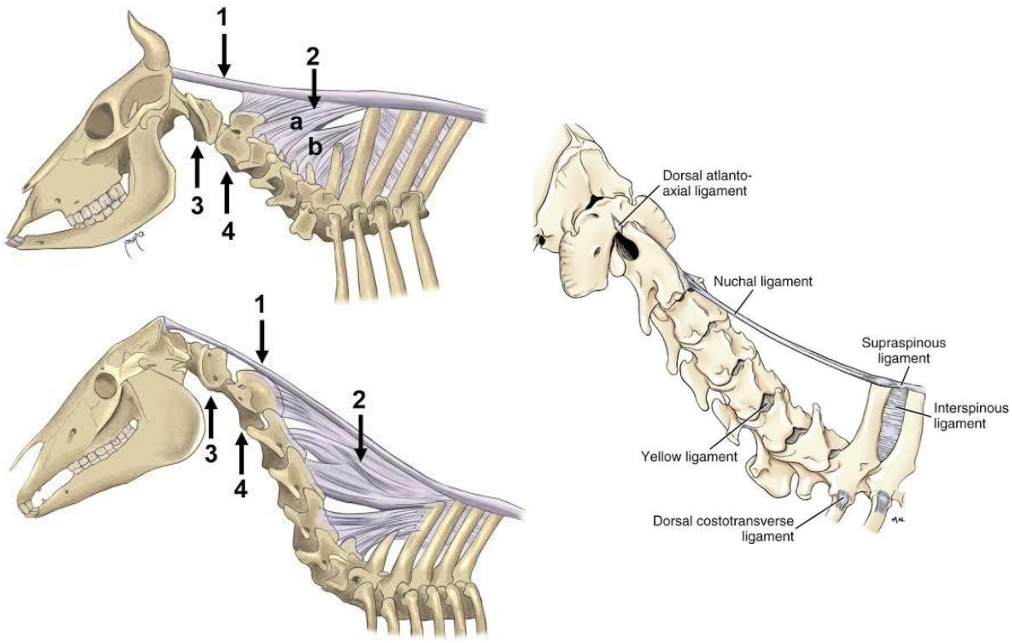


Figure 9.10: Schematic presentation of the Bovine, Equine and Canine neck ligaments.
1, Funicular part of Nuchal ligament, 2, Lamella part of Nuchal ligament (a-cranial part; b-caudal part), 3, Atlas vertebra, 4, Axis vertebra,

ACTIVITY: Fill in the table below with the appropriate

s/n	Joint	Classification			Articular surfaces	Other structures	Movement
		Nature of uniting medium	Nature of articular surface	Nature of movement			
1.	Intercentral						
2.	Interneural						
3.	Atlanto-occipital						
4.	Atlanto-axial						
5.	Intertransverse						
6,	Sacral						
7.	Caudal						

Chapter 10: **ARTICULATIONS OF THE THORAX**

INSTRUCTION:

Examine the articulated skeleton of any species and identify the following articulations/joints:

Costovertebral articulations

Each typical rib forms two joints with the vertebral column, one by its head, and one by its tubercle.

a) Articulation of the head of the ribs

These form trochoid (pivot) synovial joints. Articular Surfaces: two facets on the head of the rib corresponding to two concave facets on the adjacent vertebral bodies. Joint capsule – light and covered by the accessory ligaments.

b) Costotransverse articulation

These are plane synovial joints. Articular surfaces are facet on the tubercle of the rib and on the transverse process of vertebra. Joint capsule is reinforced by the costotransverse ligament.

Movement: Chiefly rotation around the axis which connects the centers of the head and tubercle of the ribs. The movement is very limited in the cranial part of the series of joints but very considerable in the caudal.

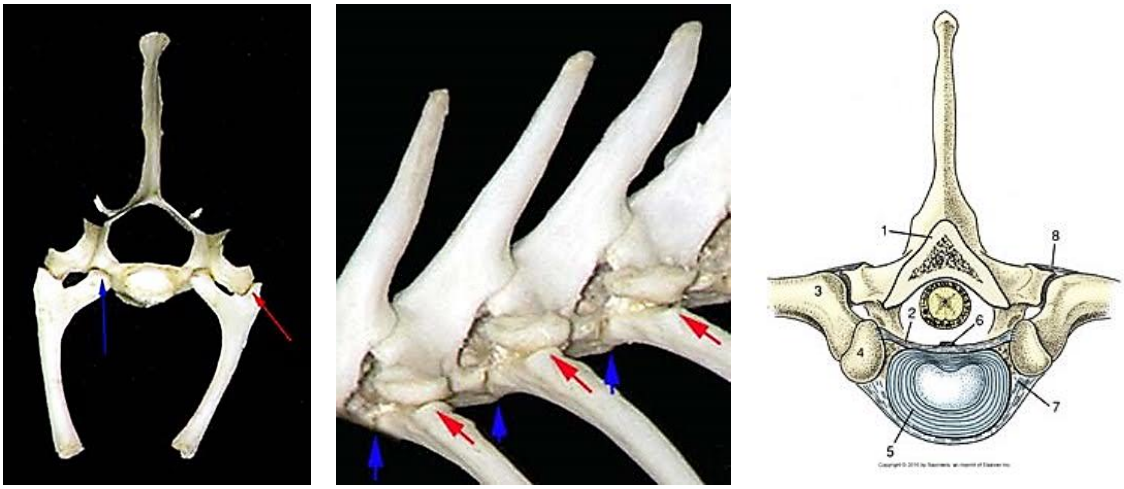


Figure 10.0 Costovertebral articulations (Blue arrow-Articulation of the head, Red arrow-Costotransverse araticulation) cranial and lateral views. 1, Lamina of vertebra; 2, Intercapital ligament; 3, Tubercle of rib; 4, Head of rib; 5, Intervertebral disc; 6, Dorsal longitudinal ligament; 7, Accessory ligament; 8 Costotransverse articulation reinforced by costotransverse ligament.

Costochondral articulations

These are fibrous joints in equine and ovine between the rib and cartilage. The 2nd to the 11th costochondral joints are synovial in the bovine in which the concave surface of the rib receives the convex end of the cartilage. They are united by the continuity of the strong periosteum and perichondrium.

Sternocostal/sternochondral articulations

These are synovial joints formed by cartilage of true ribs and the sternum. Movement is rotation around a nearly vertical axis except in the cases of the 1st pair of joints.

Sternal articulations

In equine, the bony segments are united by persisting cartilage. In the bovine, the first segment of the sternum forms with the body a synovial intersternal joint. The cranial joint surface is concave and is completed laterally by the 2nd costal cartilages. There is a close capsule and the joint surfaces are attached to each other by an interarticular ligament. Limited lateral movement is possible. In the ovine, the joint is a synchondrosis. Both surfaces of the sternum are covered by a layer of fibrous tissue.

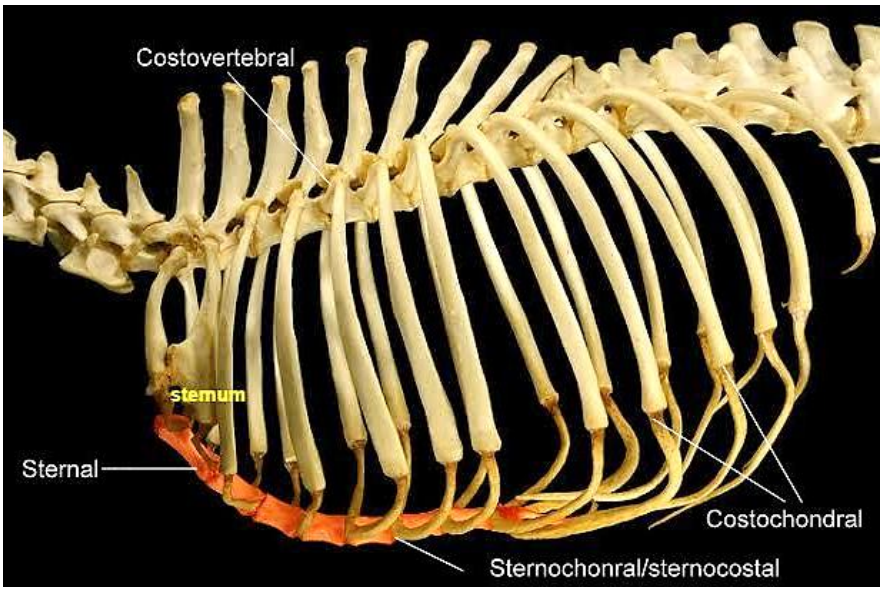


Figure 10.1: Canine articulations of the thorax

ACTIVITY:

Fill in the table below with the appropriate

s/n	Joint	Classification			Articular surfaces	Other structures	Movement
		Nature of uniting medium	Nature of articular surface	Nature of movement			
1.	Articulations of the head						
2.	Costotransverse						
3.	Costochondral						
4.	Sternochondral						
5.	Sternal						

Chapter 11: **ARTICULATIONS OF THE FORE LIMB**

The fore or thoracic limb is attached by muscles (Trapezius, Rhomboideus, Latissimus dorsi, serratus ventralis cervicis, serratus ventralis thoracis) to the trunk forming a false joint called **synsarcosis**. This is due to the absence of a clavicle. The movement of the shoulder on the thoracic wall is chiefly rotation around a transverse axis passing through the scapula caudal to the dorsal part of the spine.

INSTRUCTION:

Examine the articulated skeleton of any species and identify the following articulations/joints:

Scapulo-Humeral (shoulder) joint

A synovial simple ball-socket joint
Articular surfaces are the Glenoid cavity of the scapula and the large convex head of the humerus.

The joint capsule is ample enough to allow the bones to be drawn apart about 2-3cm: the capsule blends with the tendons of the supraspinatus, infraspinatus and subscapularis muscles. In the carnivores, the capsule also blends with the tendon of origin of the biceps brachii. In horse and ox, the capsule is separated from the tendon by the intertuberal bursa.

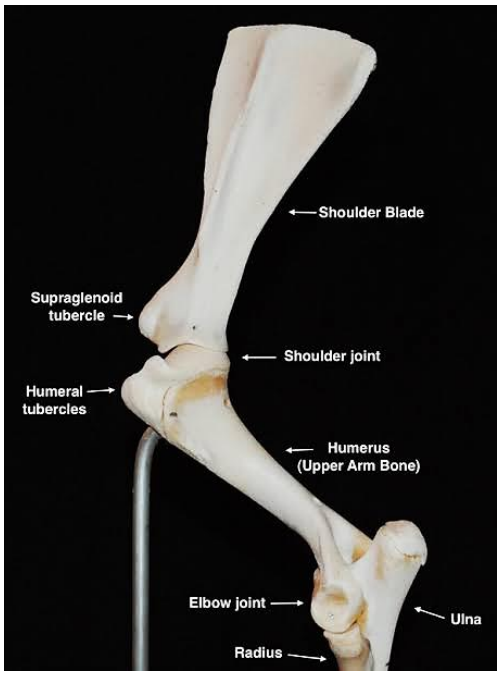


Figure 11.0: Equine shoulder and elbow joint, lateral view.

There are no well differentiated ligaments, however, its capsule is thickened laterally and medially in the dog and cranially in the horse to form weak glenohumeral ligaments. Maintenance of joint stability however is by the large size of the articular head of the humerus and the tendons of the supraspinatus, infraspinatus, teres major and biceps brachii muscles which pass over the joint and attach close to it.

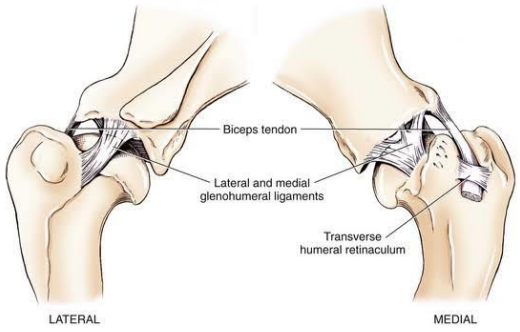


Figure 11.1: Canine shoulder joint

Movement is mainly flexion and extension although a small amount of abduction, adduction and rotation is possible.

Elbow (cubital) joint

A synovial, compound (having more than two surfaces) consisting of three articulations:

a) The humeroradial joint:

In the cat, this joint is formed between the capitulum of humerus and head of the radius but in the dog a portion of humeral trochlea is involved. In ungulates, the entire trochlea participates in the joint.

b) The humeroulnar joint:

This joint is formed between the trochlea of the humerus and trochlear notch of the ulna.

c) The proximal radioulnar joint:

This joint is absent in ungulates. In the carnivores it is formed between the proximal part of the radius and the radial notch of the ulna. It permits rotation of the forearm.
A common joint cavity exists for the three articulations.

Lateral and medial collateral ligamentshaving short and long legs, oblique ligament cranially and interosseous ligaments (occupying the interosseous space) are present in ungulates.
In the dog, additional ligaments (olecranon ligament caudally and the annular ligament enclosing the radius) are seen.

Movements are flexion and extension mainly and a limited amount of rotation (supination and pronation) in the dog.

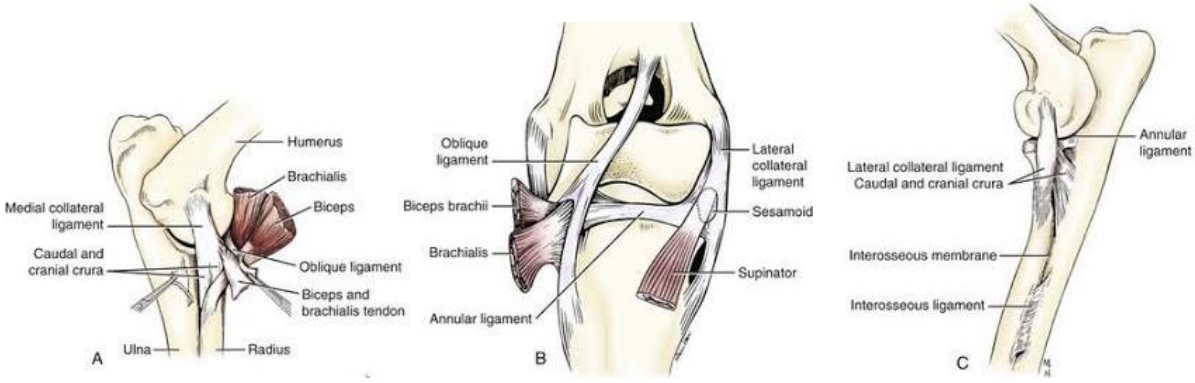


Figure 11.2: Canine elbow joint

Carpal joint

A synovial, compound joint consisting of 4 groups of articulations

i) Antebrachiocarpal joint:
Formed between the distal extremities of the radius and ulna and the proximal row of carpal bones

ii) Middle carpal joint:
Formed between the proximal and distal rows of carpal bones

iii) Intercarpal joint:
Formed longitudinally between the carpal bones of each row

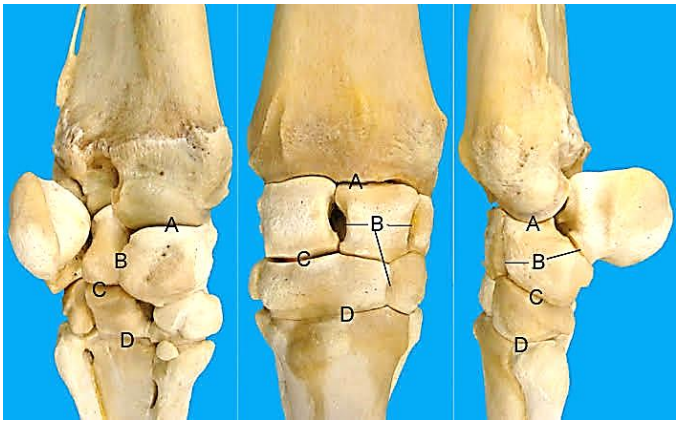


Figure 11.3: Equine carpal joint, Caudal, cranial and lateral views. A- Antebrachiocarpal, B- Intercarpal, C- Middle carpal, D- Carpometacarpal.

iv) Carpometacarpal joint:
Formed between the distal row of carpal bones and proximal ends of metacarpal bones

The fibrous layer of the joint capsule is common to all the articulations, attaching to the radius and ulna proximally and to the metacarpal bones distally. Each articulation has its own synovial membranes sac which attaches around the articular margins of the bones i.e. radiocarpal sac, intercarpal sac and carpometacarpal sac. However the middle carpal and carpometacarpal joints are in communication.

The dorsal part of the capsule is formed by dorsal carpal ligament (extensor retinaculum) which assists. The palmar part of the capsule is reinforced by palmar carpal ligament (flexor retinaculum) which forms the carpal canal containing superficial and deep digital flexor tendon.

Ligaments associated with this joint include:

In the horse, the medial and lateral collateral ligaments are long and extend between the radius and the metacarpal bones. In addition they unite the bones of the carpus on each side. Other ligaments include the proximal, middle and distal ligaments of the accessory carpal bone which join the accessory carpal to the radius, the ulnar carpal, 4th carpal and lateral splint bone. Short transverse ligaments unite adjacent carpal bones. Carpometacarpal ligaments unite the distal carpal to the metacarpals.

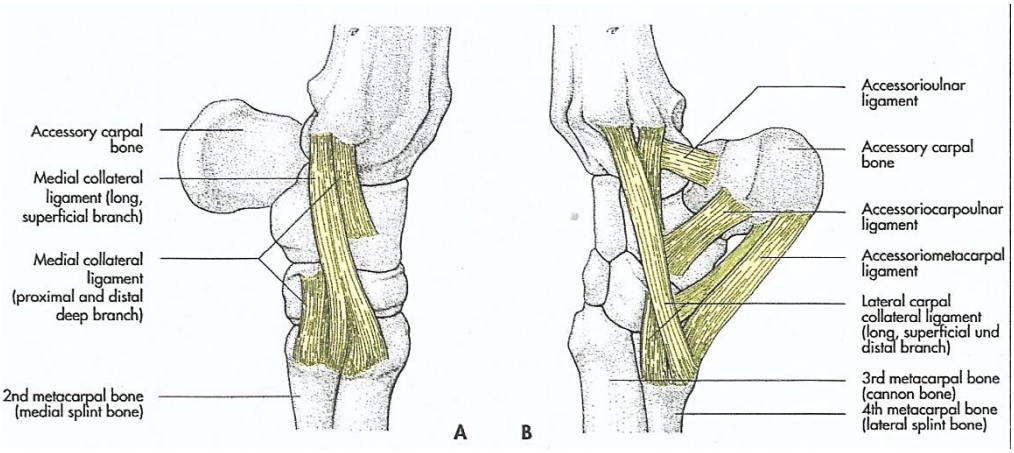


Figure 11.4 Carpal joint of the horse, medial (A) and lateral (B) views

In the dog, carpal ligaments are all short and include the:
i) Radial and ulnar collateral ligaments (radius and ulna to radio-carpal and ulna-carpal)
ii) Dorsal radiocarpal ligament (radius to ulnar carpal)
iii) Palmar-ulnar carpal ligament (ulna to radial carpal)
iv) Palmar radiocarpal ligament (radius to radial carpal)
v) A ligament passing between the palmarolateral aspects of the radius and the lateral surface of the radial carpal bone.
v) Two ligaments joining the accessory carpal bone to the 4th and 5th metacarpals.
vi) Short ligaments uniting the carpal bones transversely within each row.

N.B: The palmar aspect of the carpal joint in the dog is supported by the carpal pad.

Movement is flexion and extension, most of which occur at the antebrachiocarpal and middle carpal joints. There is in addition some adduction and abduction.

Intermetacarpal joint

In the bovine the small (5th) metacarpal bone articulates with the large metacarpal. The joint cavity is connected with that of the carpometacarpal sac. The proximal end of the small metacarpal bone is attached by a ligament to the 4th carpal and another band extends from the distal part to the side of the large metacarpal. There is also an interosseous ligament which is permanent and allows a small amount of movement. The 3rd and 4th metarcarpal are a syndesmosis which ossifies later in life.

In the horse, opposed surfaces of the shafts of the splint bones and 3rd metacarpal bone are closely united by an interosseus metacarpal ligament, which often undergoes more or less extensive ossification.

In the pig, the chief metacarpal bones (3rd and 4th) and the second to the fifth in the dog articulate with each other at their proximal ends and their shafts are connected by interosseous ligaments although they are not closely united as in the horse.

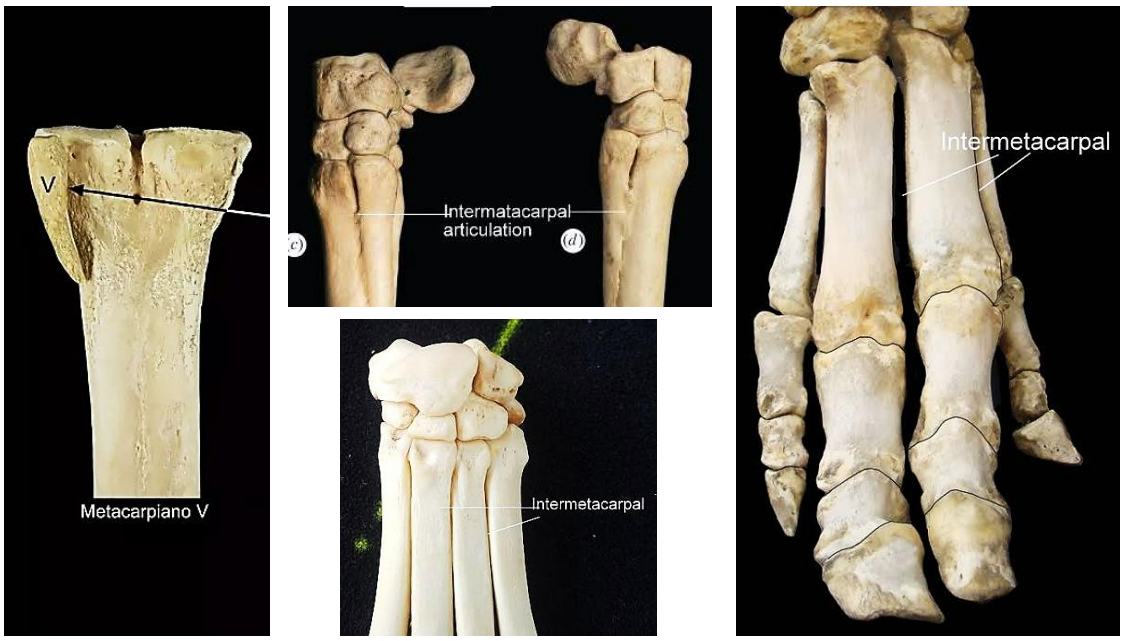


Figure 11.5: Intermetacarpal joints in the bovine, equine, canine and porcine

Metacarpophalangeal (fetlock) joint

A synovial joint formed by the distal condyle of the large metacarpal bone, the proximal end of the proximal phalanx and the proximal sesamoid bones.

In the ox, there are two joints one for each digit. The two joint capsules communicate on the palmar aspect of the limb.

In the dog, there are five joints but included in the four main joints (digits II – V) are two palmar and one dorsal sesamoid bone. Each joint has its own joint capsule.

In the horse, the joint capsule extends proximally between the large metacarpal bone and the bifurcation of the suspensory ligament.

Ligaments include:
i. Collateral ligaments – Placed on the medial and lateral sides of the joint
ii. Interdigital ligament – Connects the digits of each limb at this point

iii. Suspensory ligament – It divides into two diverging branches at the distal third of the metacarpus with each branch passing to the abaxial face of the corresponding sesamoid on which a considerable part attaches. The remainder passes obliquely distally and dorsally to the dorsal surface of the proximal phalanx to join the digital extensor tendon to limit palmar flexion of the interphalangeal joints in certain phases of movement. The principal function of this ligament is to support the fetlock by preventing excessive dorsal flexion of the joint when weight is put on the limb.

iv. Axial and abaxial collateral ligaments – Placed on the lateral and medial aspect of the joint. Intersesamoidean ligament is fibrocartilaginous and unites the sesamoid bones

v. Collateral sesamoidean ligaments - connect the sesamoids to the third metacarpal bone laterally and medially.

vi. Metacarpo-intersesamoidean ligament - connects the sesamoids to the third metacarpal bone proximally.

vi. Superficial or straight sesamoidean ligament - is a distal continuation of the suspensory ligament and extends from the sesamoid bones and the intersesamoidean ligament to the firbrocartilage lip on the palmar surface of the proximal phalanx. N.B: This is absent in the Bovine.

vii. Middle or oblique sesamoidean ligaments - attach distally to the palmar surface of the proximal phalanx.

viii. Deep or cruciate sesamoidean ligaments - comprise two bands of fibers crossing from the bases of the sesamoids to the opposite eminence on the proximal end of the proximal phalanx.

These ligaments function to assist the suspensory ligament in supporting the fetlock joint. The oblique sesamoidean ligaments also assist the superficial digital flexor tendon in preventing the pastern joint buckling forwards when the foot hits the ground.

Movement is flexion and extension.

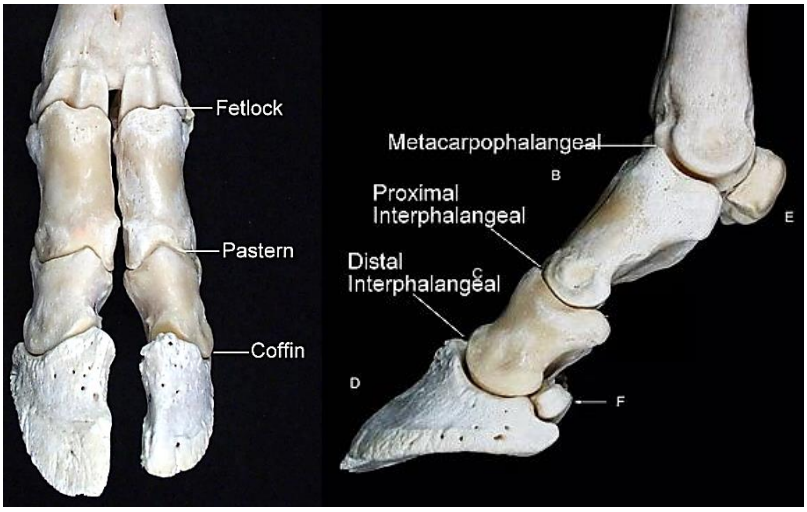


Figure 11.6: Bovine Fetlock, pastern and coffin joints (Dorsal and lateral views)

Proximal interphalangeal (Pastern) Joint

A synovial joint formed between the distal end of proximal phalanx and proximal end of middle phalanx. In the ruminants, the two joints in each limb have separate capsules but indistinct collateral ligaments. The joint capsule blends with digital extensor tendon and collateral ligament.

Ligaments include the following: Central and collateral palmar ligaments. The two digits of each limb are held by the interdigital ligament. Movements are flexion and extension though limited.

Distal interphalangeal (Coffin) joint

A synovial joint formed between the distal end of middle phalanx and proximal end of distal phalanx and distal sesamoid bone.

Joint capsule: the dorsal pouch extends proximally below the digital extensor tendon and palmar pouch lies below the navicular bone and its ligament.

Ligaments: medial and lateral collateral ligaments. N.B: In the Dog, Two dorsal elastic ligaments are located dorsally extending from the proximal extremity of the second phalanx to the proximal extremity of the last phalanx.

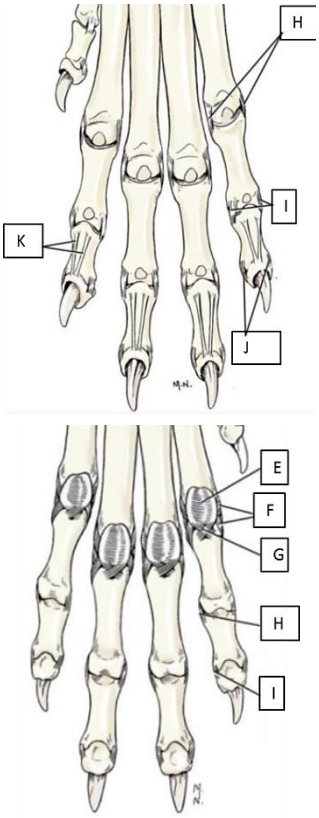


Figure 11.7: Schematic presentation of the Canine digits showing fetlock, pastern and coffin joints with some ligaments.
E – Palmar ligament; F – Median sessamoidean ligament; G – cruciate ligament of sessamoid bone; H – Collateral ligament of proximal interphalangeal; H- collateral lig. of proximal metacarpophalangeal joint; I – collateral lig. of proximal interphalangeal joint; J – collateral lig. of distal interphalangeal joint, K – Dorsal elastic ligament, I – collateral ligament of distal interphalangeal

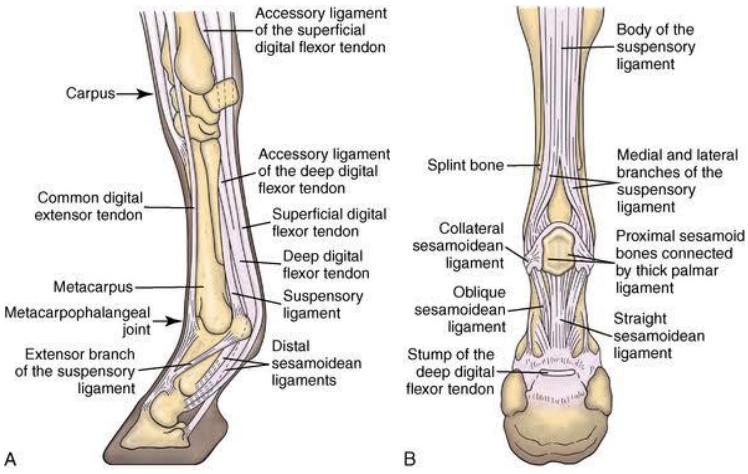


Figure 11.8: Schematic presentation of Equine manus showing associated joints and ligaments

Stay apparatus of the Horse forelimb:

The stay apparatus consists of structures in the fore and hindlimb which permits the animal to stand with minimum muscular effort. The apparatus is well developed in the equine species hence their ability to stand for long hours even while sleeping.

The forelimb of the horse bears a larger proportion of the body weight than the hindlimb with the center of gravity in the standing animal about 43% of the distance from the shoulder joint to the tuber ischii. The weight is transmitted to the limb via the serratus ventralis muscle which is attached to the facies serrata of the scapula. Since a vertical line dropped from the facies serrata falls behind the shoulder joint, directly through the elbow joint, and in front of the remaining joints, the limb if not supported will collapse by flexion of the shoulder and elbow joints and over – extension of the carpal, fetlock and phalangeal joints. The stay apparatus functions to prevent this collapse from taking place by fixing the joints in position.

Structures that make up the stay apparatus of the Horse forelimb include the following:

1. Serratus ventralis muscle
2. Biceps brachii muscle
3. Lateral collateral ligament of the elbow
4. Lacertus fibrosus
5. Extensor carpi radialis
6. Accessory ligament of the carpus
7. Superficial digital flexor
8. Deep digital flexor
9. Suspensory ligament
10. Superficial sessamoidean ligament
11. Common digital extensor

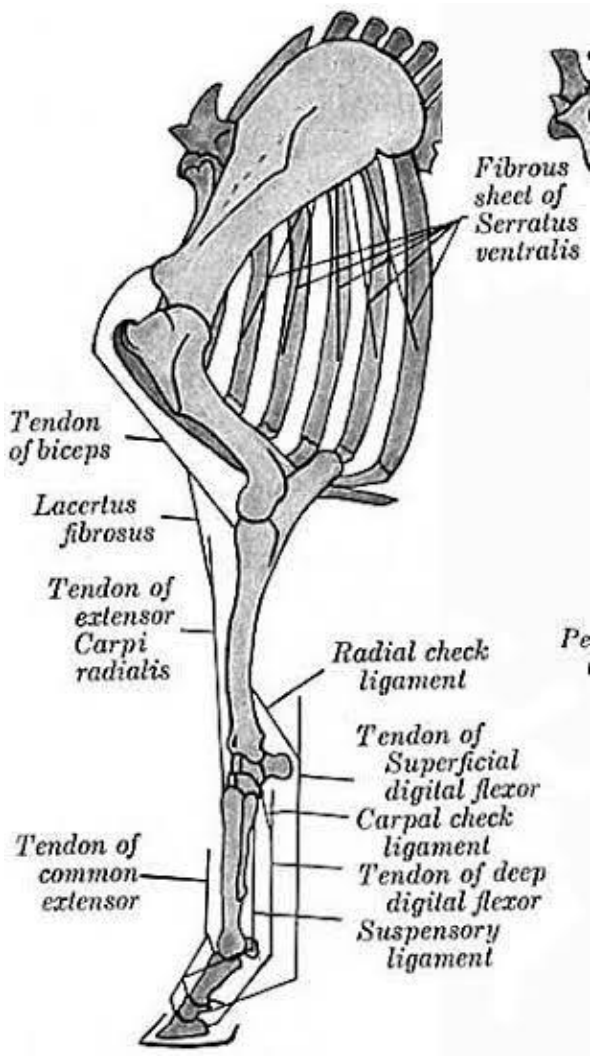
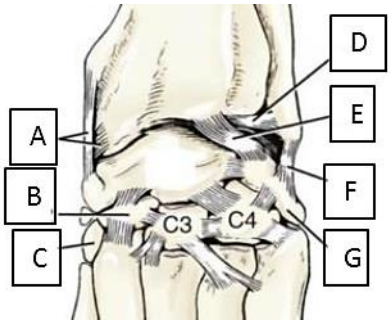
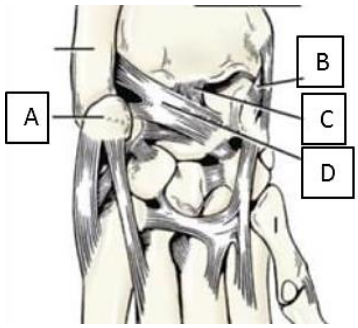


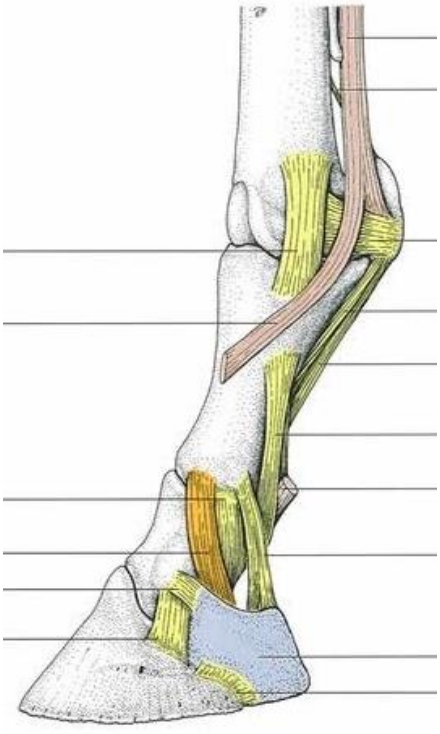
Figure 11.9: Schematic presentation of the stay apparatus of the equine fore limb.

ACTIVITY: Using arrows, label the ligaments (lettered or not) of the carpal joint of the dog as shown in the schematic presentation below. Also sketch the dorsal surface of the equine carpal joint showing its ligaments and label the pointed structures of the equine manus.





Equine carpal joint (Dorsal)



ACTIVITY: Fill in the table below with the appropriate features of the following articulations of the canine species.

s/n	Joint	Classification			Articular surfaces	Other structures	Movement
		Nature of uniting medium	Nature of articular surface	Nature of movement			
1.	Shoulder joint						
2.	Humero-radial						
3.	Humero-ulna						
4.	Proximal radio-ulna						
5.	Antebrachiocarpal						
6,	Middle carpal						

7.	Intercarpal						
8.	Carpometacarpal						
9.	Intermetacarpal						
10.	Metacarpophalageal						
11.	Proximal interphalangeal						
12.	Distal interphalangeal						

Chapter 12: **ARTICULATIONS OF THE HIND LIMB**

INSTRUCTION:

Examine the articulated skeleton of any species and identify the following articulations/joints:

Sacroiliac Joint

A synovial and cartilaginous joint formed between the auricular surfaces of the sacrum and ilium. The surfaces are marked by reciprocal eminences and depressions and covered by a thin layer of cartilage. The joint cavity is a cleft that is often crossed by fibrous bands.
Joint capsule is very close fitting and attached to the margins of the auricular surfaces.
Ligaments include the strong dorsal and ventral sacroiliac ligaments
Movement is more or less absent.

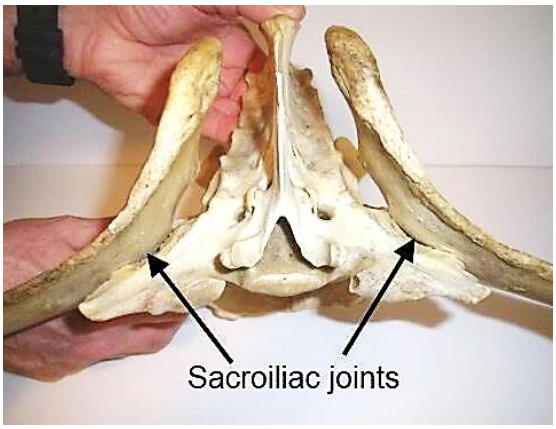


Figure 12.0: Sacroiliac joint

The following ligaments although not directly connected with the sacroiliac joint are regarded as accessory to it:

a) Dorsal sacroiliac ligament

It is attached to the sacral tuberosity and summits of the sacral spines. Another triangular thick sheet of this ligament is attached cranially to the sacral tuberosity and adjacent part of the medial border of the ilium dorsal to the greater ischiatic notch and ventrally to the lateral border of the sacrum. It blends ventrally with the broad sacrotuberal ligament and caudally with the caudal fascia.

b) Broad sacrotuberal ligament

It is an extensive quadrilateral sheet which completes the lateral pelvic wall. Its dorsal border is attached to the border of the sacrum and the transverse processes of the first and second coccygeal vertebrae. Its ventral border is attached to the ischiatic spine and tuber. Between these it bridges over the lateral border of the sacrum and completes the lesser ischiatic foramen. The cranial border is concave and completes the greater ischiatic foramen. The caudal border is fused with the vertebral head of the semimembranosus. In the Bovine, it is called the Sacroichiatic ligament. In the Dog, it is in the form of a fibrous band that extends from the sacrum to the ischial tuber. It does not cover the lateral wall.

c) Iliolumbar ligament

It is a triangular sheet attaching ends of the lumbar transverse processes to the ventral surface of the ilium ventral to the attachment of the longissimus muscles.

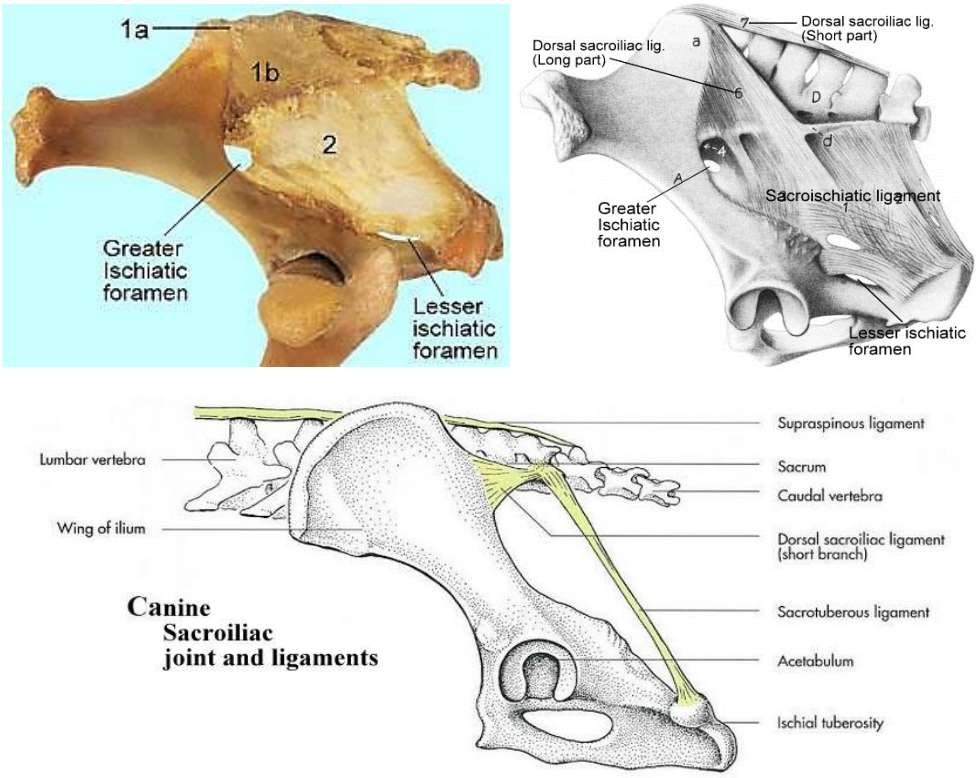


Figure 12.1: Bovine, equine and canine ligaments associated with the sacroiliac joint.

Pelvic Symphysis

This is formed by the junction of the os coxae meeting its fellow at the ventral median line. In the young the bones are united by cartilage; in the adult the cartilage is gradually replaced by bone with ossification proceeding in the craniocaudal direction with fusion between the ischial usually incomplete.

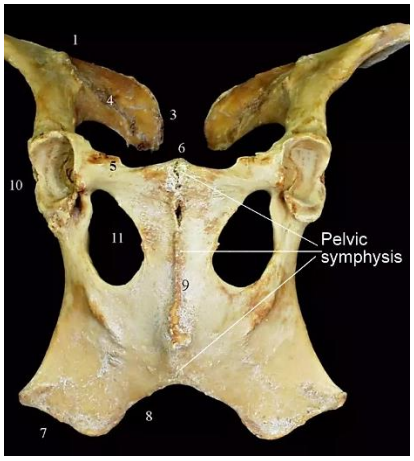


Figure 12.2: Bovine Ossa coxarum, ventral view

Coxal or Coxofemoral or Hip Joint



Figure 12.3: Coxofemoral joint

A synovial, simple ball and socket joint formed by the acetabulum of the os coxae and head of the femur. The acetabulum is deepened by a ring of fibrocartilage, the acetabular lip attached to the bony margin. The Joint capsule is capacious and attached around the margin of the acetabulum and neck of femur.

Ligaments involved in this joint are:

a) Ligament of the head of femur (round ligament**)**

This extends from a wide attachment in the acetabular fossa to the fovea on the head of the femur.

b) Accessory ligament of the femur

This occurs only in the equidae. It extends outwards, backwards and upwards from the pubic tendon along the groove on the ventral surface of the pubis, through the acetabular notch to end in the deep fovea capitis. This ligament assists in maintaining the general stability of the joint but severely limits inward rotation (pronation) of the thigh.

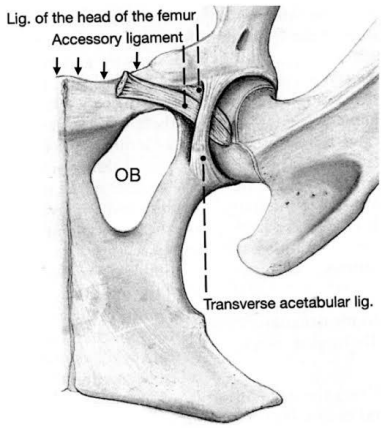


Figure 12.4: Schematic presentation of the ligaments of the coxofemoral joint.

Movement is mainly extension and flexion in a sagittal plane, but also abduction, adduction and rotation are possible.

Stifle (Genual) Joint

This is the largest and most elaborate of all joints. It is a compound synovial joint made up of two joints in ungulates but up to four in the dog:

i) *Femoropatellar articulation* is formed between the trochlea of the femur and the articular surface of the patella.

ii) *Femorotibial articulation* is formed the condyles of the femur and condyles of the tibia. Two semilunar fibrocartilaginous discs, the medial and lateral menisci fill the space between the femur and tibia reducing the incongruence between the articular surfaces.

iii) *Femorofabellar articulations* of dog are formed between the facets on the femoral epicondyle and the lateral and medial fabellae – sesamoid bones embedded in the tendons of origin of the gastrocnemius muscle.

iv) *Proximal tibiofibular articulation* of the dog is formed between the head of the fibula and the facet below the lateral condyle of the tibia.

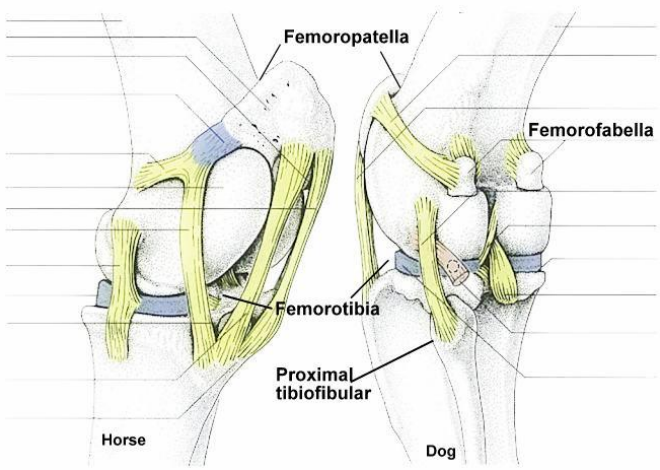


Figure 12.5: Schematic presentation of Equine (Cranio-lateral) and Canine (Caudo-lateral) stifle joint.

The Joint capsule forms three sacs: lateral and medial femorotibial sacs and a sac beneath the patella. The two femorotibial sacs are partly divided by the menisci into proximal and distal compartments. The patellar sac is very well developed.

Ligaments involved in this joint include the following:

i) Medial and lateral collateral (femorotibial) ligaments - The medial (tibial) collateral ligament has a superficial and deep part and extends from the medial femoral epicondyle to the tibia below the medial condyle. The lateral (fibular) collateral ligament extends from the lateral femoral epicondyle the head of the fibula.

ii) Meniscal ligaments attach the cranial and caudal horns of the menisci to the femur and tibia. Four ligaments attach the menisci to the cranial and caudal intercondylar areas of the tibia – cranial and caudal tibial ligaments of the medial meniscus; the cranial and caudal tibial ligaments of the lateral meniscus.
The meniscofemoral ligament extends obliquely from the caudal part of the lateral meniscus to the intercondylar fossa of the femur.

The transverse (intermeniscal) ligament is present in the dog and ox and unites the two cranial tibial meniscal ligaments.

iii) Cruciate ligaments are two strong bands which extend between the articular surfaces of the femur and tibia and the wind around each other in a spiral fashion. They are intra-articular and named according to their tibial attachments as cranial and caudal cruciate ligament.

iv) Medial and lateral femoropatellar ligaments are delicate bands extending from the femoral epicondyles (the fabellae also in the dog) to the medial and lateral borders of the patella reinforcing the capsule on either side.

v) Patellar ligaments including lateral, middle and medial patellar ligaments in the horse and ox which in reality are the tendons of insertion of the quadriceps femoris and biceps femoris muscles and transmit the action of the latter to the tibia. All the ligaments insert close together on the tibial tuberosity. There is one ligament in the dog.

Movements:

The principal movements are flexion and extension. In the dog rotary movements of the tibia on the femur can be shown to occur in both extension and flexion. In the femoropatellar joint the patella glides upwards on the femoral trochlea in extension and downwards in flexion.

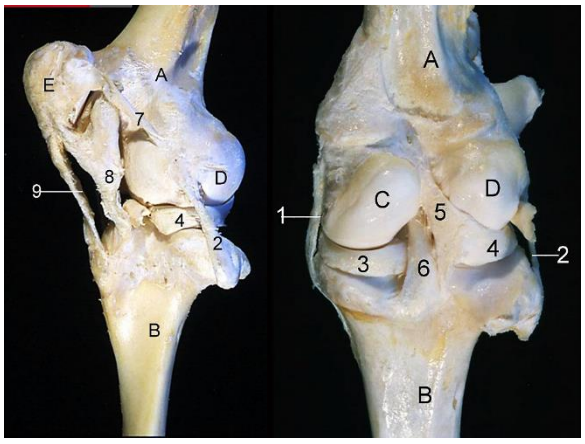


Figure 12.6: Bovine stifle, lateral and caudal views

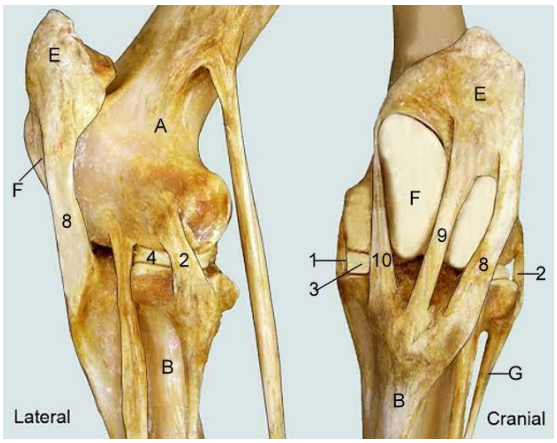


Figure 12.7: Equine stifle, lateral and cranial views

A-Femur, B-Tibia, C-Medial condyle, D-Lateral condyle, E-Patella, F-Trochlea, G-Fibula, 1, Medial collateral ligament, 2, Lateral collateral ligament, 3, Medial meniscus, 4, Lateral meniscus, 5, Lateral meniscofemoral ligament, 6, Cruxiate ligament, 7, Lateral femoropatella ligament, 8, Lateral patella ligament, 9, Middle patella ligament, 10, Medial patella ligament.

Tarsal (Hock) Joint

A synovial composite joint made up of four articulations:

i. *Tarsocrural (Talocrural) articulation* is formed between the tibial cochlea and the trochlea of the talus.

ii. *Proximal intertarsal articulation* is formed between the talus and calcaneus proximally and the central and fourth tarsal bones distally. The talus of the ox articulates with the centroquartal bone by means of a trochlea.

iii. *Distal intertarsal articulation* is formed between the central tarsal bone proximally, fourth tarsal bone laterally and the first, second and third tarsal distally.

iv. Tarsometatarsal articulation is formed between the distal row of tarsal bones and the proximal articular surface of the metatarsal bones.

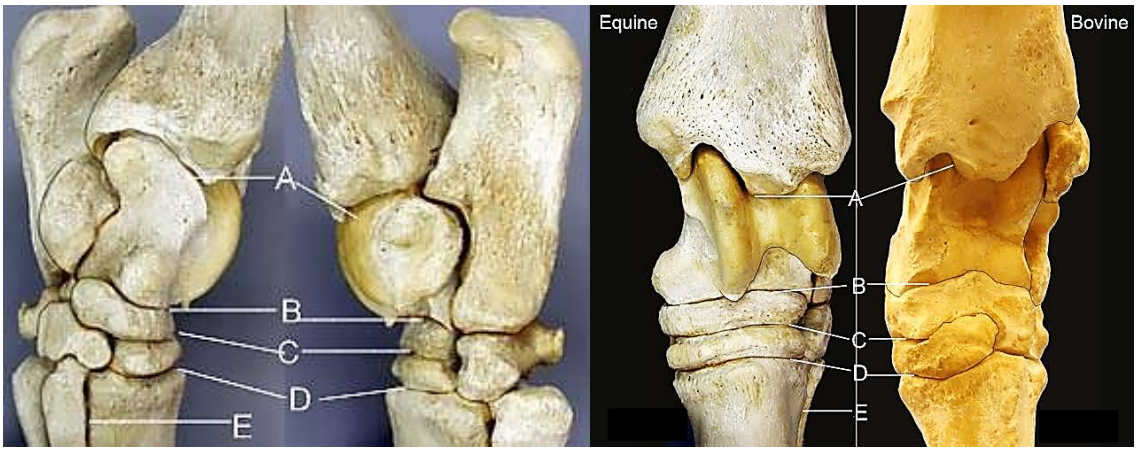


Figure 12.8: Equine (Lateral, medial and cranial view) and Bovine (cranial view) Hock joint.
A-Tarsocrural, B-Proximal intertarsal, C-Distal intertarsal, D-Tarsometatarsal, E-Intertarsal.

The Joint capsule (fibrous layer) extends from the distal extremities of the tibia and fibula to the proximal extremities of the metatarsal bones. The synovial layer attaches to the margins of the articular cartilages.

Ligaments involved include:

i) Medial collateral ligament - originates on the medial malleolus and consists of long and short parts. The long part inserts on the talus and proximal ends of the second and third metatarsals. The short part extends caudally below the long part in the form of two bands which insert on the talus.

ii) Lateral collateral ligament - originates on the lateral malleolus and consists of long and short parts. The long part inserts on the calcaneus, the fourth tarsal and third and fourth metatarsals. The short part extends caudally below the long part and inserts on the talus and calcaneus.

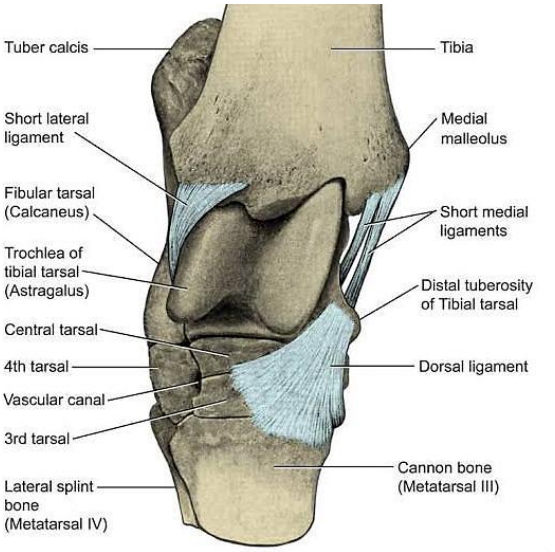


Figure 12.9: Equine hock joint (cranial view) showing associated ligaments.

iii) Long plantar ligament extends on the lateroplantar aspect of the hock from the calcaneus to the fourth tarsal and metatarsal bones.

iv) Dorsal ligament - is a triangular sheet attaching proximally to the medial surface of the talus and distally to the second and third metatarsals.

The main movement in tarsal joint is flexion and extension occurring principally at the talocrural joint. A very small amount of gliding is possible at the other joints. The trochlea at the distal end of the ox talus enables a relatively large degree of flexion to occur at the proximal intertarsal joint.

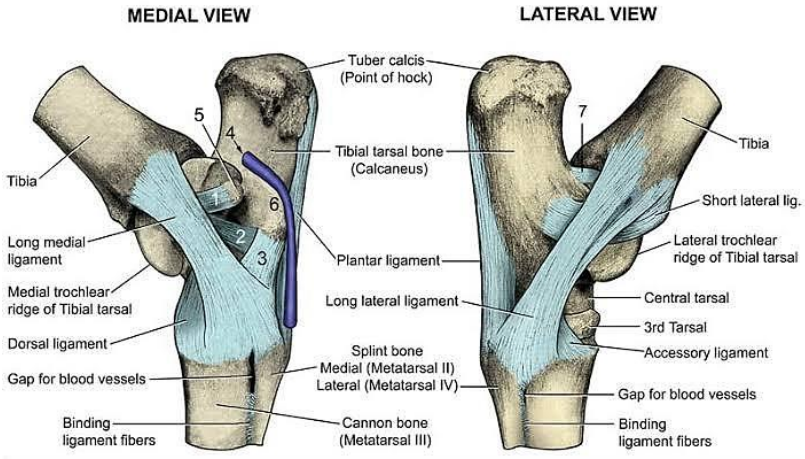


Figure 12.10: Equine hock joint (medial and lateral views) showing associated ligaments

Metatarsophalangeal and Interphalangeal Joints

These joints are similar to the comparable joints in the forelimb.

Components of the Stay apparatus of the Horse hind limb

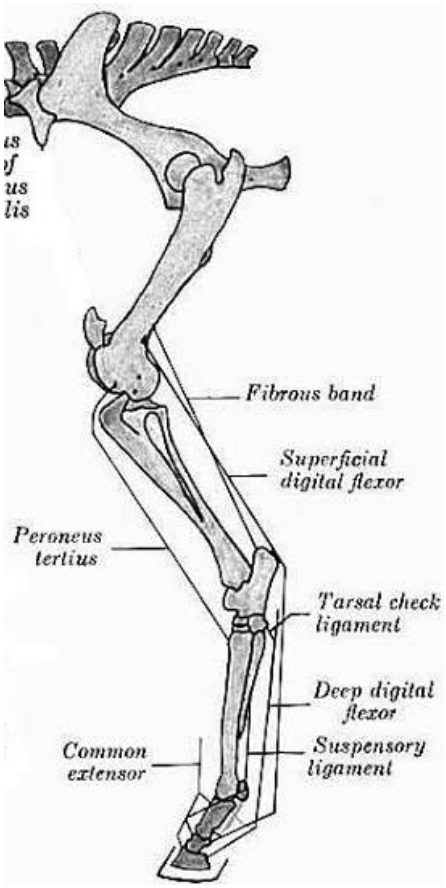
Main components of hind limb stay apparatus which allow the horse support body weight with minimum muscular effort.

Collapse of hind limb under weight of the body will involve flexion of the hip, stifle and hock joints and over- extension of fetlock and phalangeal joints.

Component of stay apparatus are designed to prevent this happening.

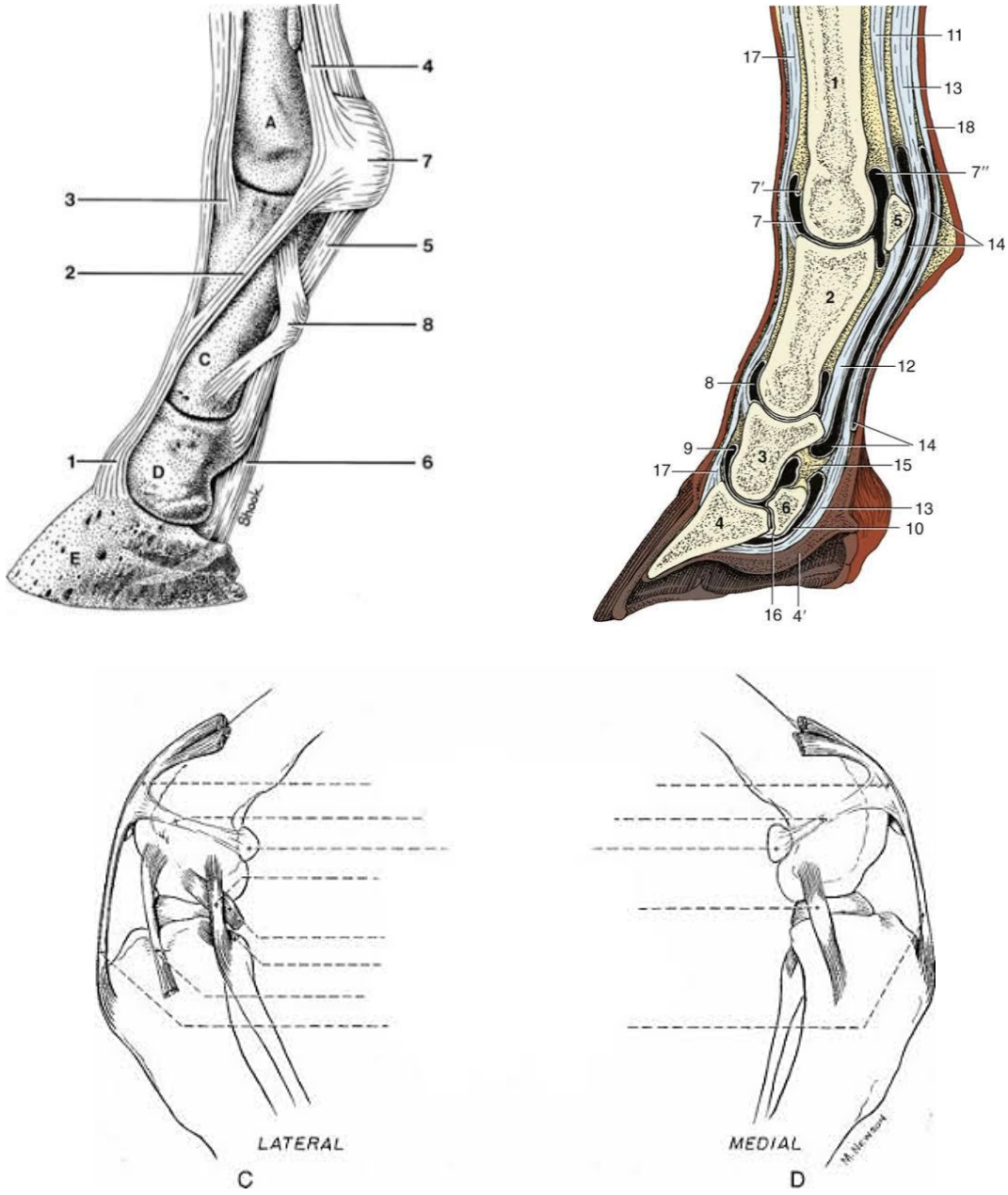
Structures that make up the stay apparatus in the Horse hind limb include the following:

1) Tensor fasciae latae
2) Fibrous band
3) Fibularis tertius
4) Flexor digitorum superfacialis
5) Accessory ligament of flexor digitorum profundus
6) Flexor digitorum profundus
7) Interossueus or suspensory ligament
8) Extensor digitorum longus



ACTIVITY:

Having studied the metacarpophalangeal and interphalangeal joints of the forelimb, label the following structures of the schematic presentations of the equine metatarsophalangeal and interphalangeal joints. Also label the pointed parts of the canine stifle joint.



ACTIVITY: Fill in the table below with the appropriate features of the following articulations of the canine species.

s/n	Joint	Classification			Articular surfaces	Other structures	Movement
		Nature of uniting medium	Nature of articular surface	Nature of movement			
1.	Sacroiliac joint						
2.	Pelvic symphysis						
3.	Coxofemoral						
4.	Femuropatella						
5.	Femurotibia						
6,	Femurofabella						

7.	Proximal tibiofibular						
8.	Talocrural						
9.	Proximal intertarsal						
10.	Distal intertarsal						
11.	Tarsometatarsal						
12.	Metatarsophalangeal						

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