

General Skeletal System

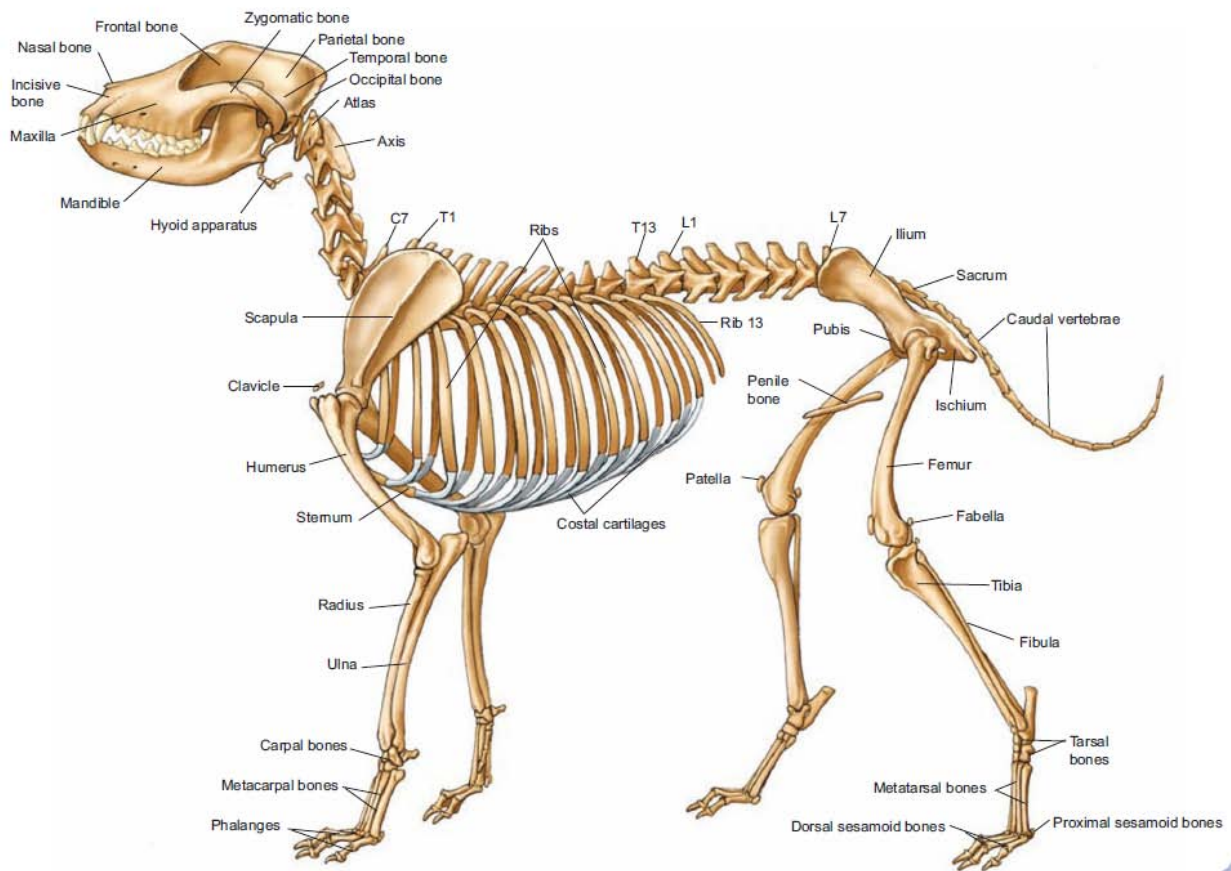


Fig. 1 Skeleton of Dog

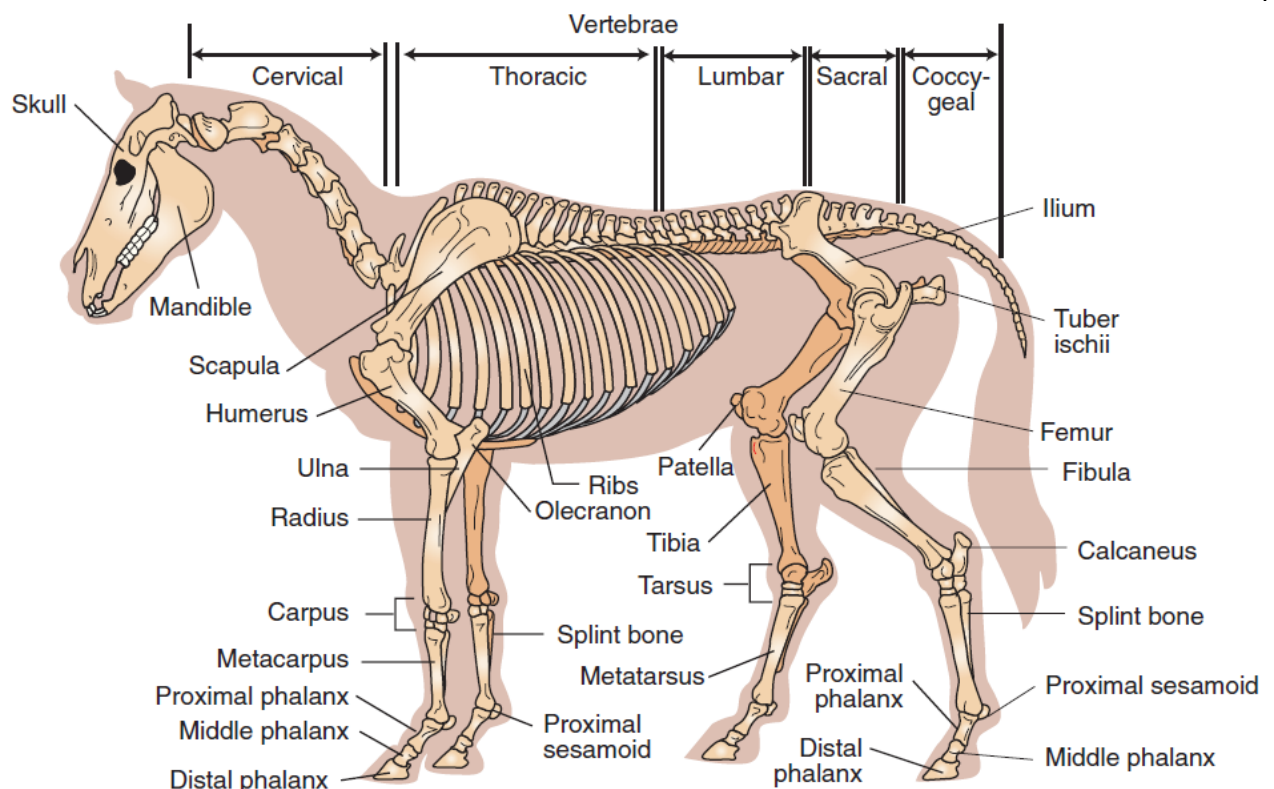


Fig. Skeleton of Horse

Skeletal system is the **'framework'** upon which the body is built – it provides support, protection and enables the animal to move.

Skeleton

Framework of hard structures which supports and protects the soft tissues of animals.

The skeleton is composed of:

- Bones
- Cartilage
- Ligaments and
- Joints

Osteology (*Ossa* means bone; *logy* means study): Study of bones that combine to form the skeleton of animal. Bone is the structural unit of skeleton.

Classification of skeleton:

1. **Axial skeleton:** form the central axis of the animal. Consists of skull, vertebral column, ribs and sternum.
2. **Appendicular skeleton:** comprising the fore and hind limbs.
3. **Splanchnic/visceral skeleton:** It is a special type of skeleton. The visceral skeleton consists of bones that form in soft organs (viscera). eg. *Os penis* of dog and cat. *Os cordis* is a bone that supports the valves in the heart of cattle and sheep; and the *os rostra* is a bone in the nose of swine

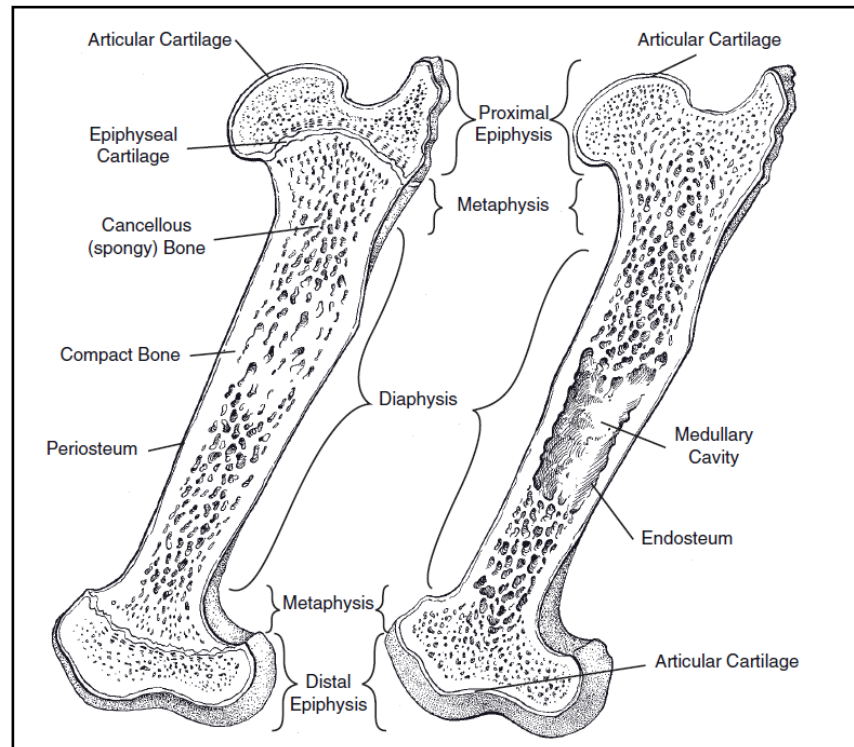


Fig. 2 Longitudinal section of long bone. Left) Immature bone (growth plates open) B) Mature bone (growth plate fused)

General features of bone

- *Compact substance*- outer; harder and compact in nature
- *Spongy substance*-inner; delicate and spongy in nature
- *Medullary cavity*- filled with marrow. Found only in the long bone
- *Periosteum*-outside covering
- *Endosteum*- inner covering
- *Epiphysis*- refers to either end of a long bone. The end closest to the body is the proximal epiphysis, and the end farthest from the body is the distal epiphysis.
- *Diaphysis*- is the cylindrical shaft of a long bone between the two epiphyses.
- *Metaphysis*-is the flared area adjacent to the epiphysis.
- *Epiphyseal cartilage or disk*-is a layer of hyaline cartilage within the metaphysis of an immature bone that separates the diaphysis from the epiphysis. This is the only area in which a bone can lengthen.
- *Articular cartilage*- is a thin layer of hyaline cartilage that covers the articular (joint) surface of a bone.

Projections, Processes, Depressions and Foramina

To be able to compare bones it is crucial to know the terminology used to describe the skeletal system. The following list of definitions is provided to aid in the study of bones and their projections, depressions and foramina.

Terminology of bones		
Articular Projections	Definition	Examples
<i>Head</i>	Spherical articular projection	Head of femur
<i>Condyle</i>	Approximately cylindrical articular mass	Medial & lateral femoral condyles
<i>Trochlea</i>	Pulley like articular mass	Trochlea of distal humerus
<i>Facet</i>	Relatively flat articular surface.	Articular facets between carpal bones
Nonarticular Projections		
<i>Process</i>	General term for bony projection.	Spinous process of vertebra
<i>Tuberosity (tuber)</i>	Relatively large nonarticular projection.	Deltoid tuberosity of humerus.
<i>Tubercle (tuberculum)</i>	Smaller projection	Greater and lesser tubercles of humerus
<i>Spine</i>	Pointed projection	spine of scapula
<i>Crest</i>	Sharp ridge	Median sacral crest
<i>Neck</i>	Cylindrical part of bone to which head is attached	Femoral neck
<i>Line (linea)</i>	Small ridge or mark on bone	Gluteal lines of ilium
Articular Depressions		
<i>Fovea</i>	Small depression	Fovea capitis on head of femur
<i>Glenoid Cavity</i>	Shallow articular concavity	Glenoid cavity of scapula
<i>Notch</i>	Indentation	Semilunar notch of ulna
<i>Acetabulum/cotyloid cavity</i>	Deep articular cavity	Acetabulum of pelvic girdle
Nonarticular Depressions		
<i>Fossa</i>	Large nonarticular depression	Supraspinous fossa of scapula
<i>Foramen (pl. foramina)</i>	Circumscribed hole in bone	Foramen magnum at base of skull
<i>Canal</i>	Tunnel through one or more bones	Vertebral canal

Acetabulum of femur

Classification of bone

The bones are commonly divided into four classes according to their shape and function.

1. **Long bones:** longer than wide. Long bones have cylindrical bodies with a round end. The rounded area at the proximal end is called head and the distal end is called condyle. They occur in the limbs.
2. **Flat bones:** they are expanded in two directions. They consist of two plates of compact bone (lamina externa and lamina interna) separated by a spongy material called diploë. e.g. flat bones of the skull, scapula and ribs.
3. **Short bones:** Somewhat similar dimensions in length, breadth, and thickness. e.g. carpus and tarsus.
4. **Irregular bones:** Irregular shape. They lie in the midline and are unpaired, e.g. vertebrae.

Some specialized types of bone are:

Sesamoid bones- these are sesame-seed-shaped bones that develop within a tendon. e.g. Patella (kneecap) is the largest sesamoid bone in the body.

Pneumatic bones- contain air filled spaces known as sinuses. They have the effect of reducing the weight of the bone, e.g. maxillary and frontal bones

Composition of bone:

Ratio of organic and inorganic content is 1: 2

Gelatin	33.30
Phosphate of lime (CaPO ₄)	57.35
Carbonate of lime (CaCO ₃)	3.85
Phosphate of magnesia (MgPO ₄)	2.05
Carbonate and chloride of sodium (NaCl and NaCO ₃)	3.45
Total	100.00

Blood supply of bone: Nutrient arteries supply blood via nutrient foramina.

Ossification (Formation of bone): The cells responsible for laying down new bone are called osteoblasts; the cells that destroy bone are called osteoclasts. Types of ossification:

- Direct /intramembranous ossification (e.g. skull bones)
- Indirect/chondral ossification-involves cartilage

Function of Bone:

- Supporting and protective framework of the body.
- Ensure locomotion and protect soft tissues.
- Contain red bone marrow and responsible for production of blood cells (Hematopoiesis) and store calcium and phosphate.

Vertebral column

Vertebral column is the fundamental part of the skeleton. It consists of a chain of median, unpaired, irregular bones which extends from the skull to the end of the tail. The vertebral column can be divided into following five regions or segments:

- Cervical (C)-neck region
- Thoracic (T)-thoracic region
- Lumbar (L)-lower back or abdominal region
- Sacral (S)-croup or pelvic region
- Caudal (Cd) or coccygeal-in the tail.

Vertebral formula: The vertebral formula expresses the number of bones in the different segments of the vertebral column. The number of vertebrae in a species is generally constant in each region except caudal region.

Vertebral formula of domestic mammals

Dog/Cat	C ₇ T ₁₃ L ₇ S ₃ Cy ₂₀₋₂₃ (variable)
Horse	C ₇ T ₁₈ L ₆ S ₅ Cy ₁₅₋₂₁
Ox	C ₇ T ₁₃ L ₆ S ₅ Cy ₁₈₋₂₀
Sheep/Goat	C ₇ T ₁₃ L ₆ S ₄₋₅ Cy ₁₃₋₁₄
Hog	C ₇ T ₁₄₋₁₅ L ₆₋₇ S ₄ Cy ₂₀₋₂₃
Chicken	C ₁₄ T ₇ LS(Lumbosacral) ₁₄ Cy ₆

Vertebra (Structural unit of vertebral column)

All typical vertebrae has common typical plan of structure. A typical vertebra consists of

- Body
- Arch
- Processes

Body

Body is generally cylindrical with a convex cranial end and a concave caudal end. Cranial and caudal extremities are attached to adjacent vertebrae by intervertebral fibrocartilage. Dorsal surface is flattened and ventral surface rounded laterally. Dorsal surface form the vertebral canal.

Arch

Arch is located on dorsal surface of the body. It consists of two lateral halves. Each half consists of pedicle and lamina. Pedicles forms lateral part of the arch and are cut into in front and behind by vertebral notches. The notches of two adjacent vertebrae form intervertebral foramina for the passage of spinal nerves

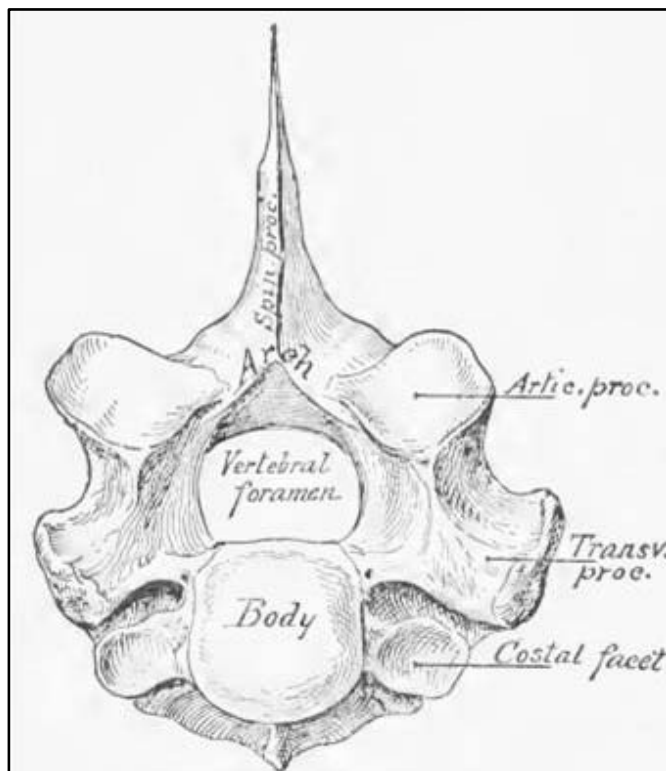


Fig. 3 General structure of a typical vertebra

and vessels. The laminae are plates which complete the arch dorsally and uniting with each other medially at the root of the spinous process.

- The body and the arch form a bony ring which encloses the vertebral foramen.
- The series of vertebral rings together with ligaments which enclose the vertebral canal. It contains spinal cord and its coverings and vessels.

Processes

Each vertebra carries a number of processes. These are:

- One spinous/dorsal process: single and project dorsally from middle of the arch.
- Four articular processes: 2 cranial and 2 caudal.
- Transverse process: 2 in number; project laterally.

Ribs (Costae)

- Elongated curved flat bones.
- Arranged in pairs.
- Generally the number of pairs of ribs is the same as the number of thoracic vertebrae vertebrae.
- Articulates dorsally with two vertebrae and ventrally by costal cartilage.
- Intercostal space: the space between two ribs.

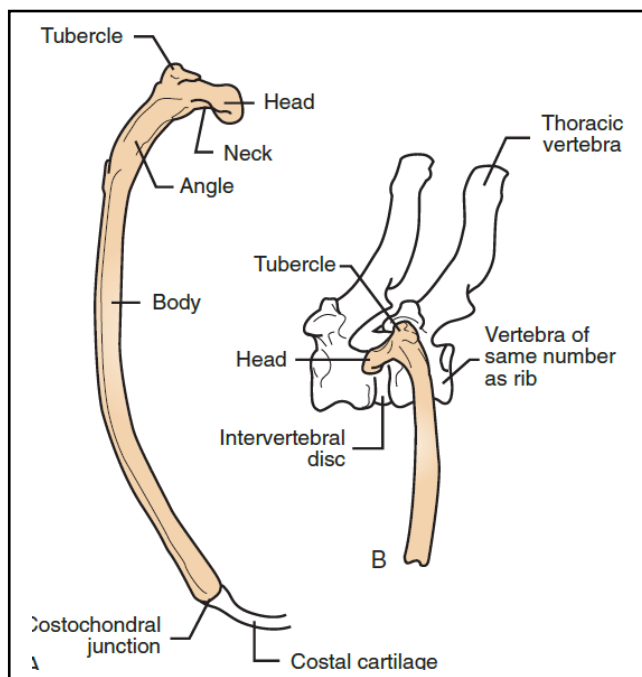


Fig. 4 Structure of Canine rib. A) Caudal view B) Lateral view

Types of Ribs: 3 types

1. True ribs/sternal ribs: attached with sternum directly. First eight pairs of ribs.
2. Asternal/false ribs: not attached directly with sternum. The ribs from pairs 9-12 are called asternal or 'false' ribs, and they attach via their costal cartilages to the adjacent rib, forming the costal arch.
3. Floating ribs: the ventral ends free in the abdominal wall. The last pair of rib (pair 13) have no attachment at their cartilaginous ends which lie free in the abdominal muscle-this pair are called the 'floating' ribs.

Structure of ribs

- A true rib consists of shaft and two extremities: vertebral and sternal
- Shaft: external surface is convex and internal surface is flattened.
- Vertebral extremity: consists of head, neck and tubercle.
- Head presents a cranial and a caudal facet for the articulation with two adjacent thoracic vertebrae.
- Neck joins the head with shaft.
- Tubercle: projects backward. Presents facets for articulation with the transverse process for articulation of the same vertebra.
- Sternal extremity: ventrally

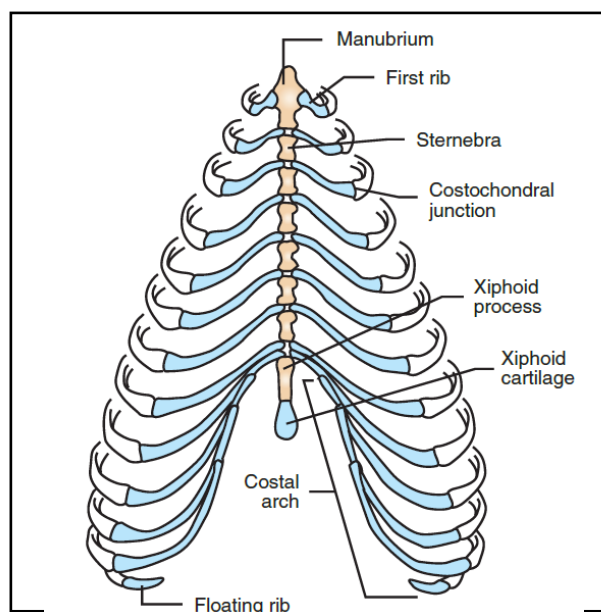


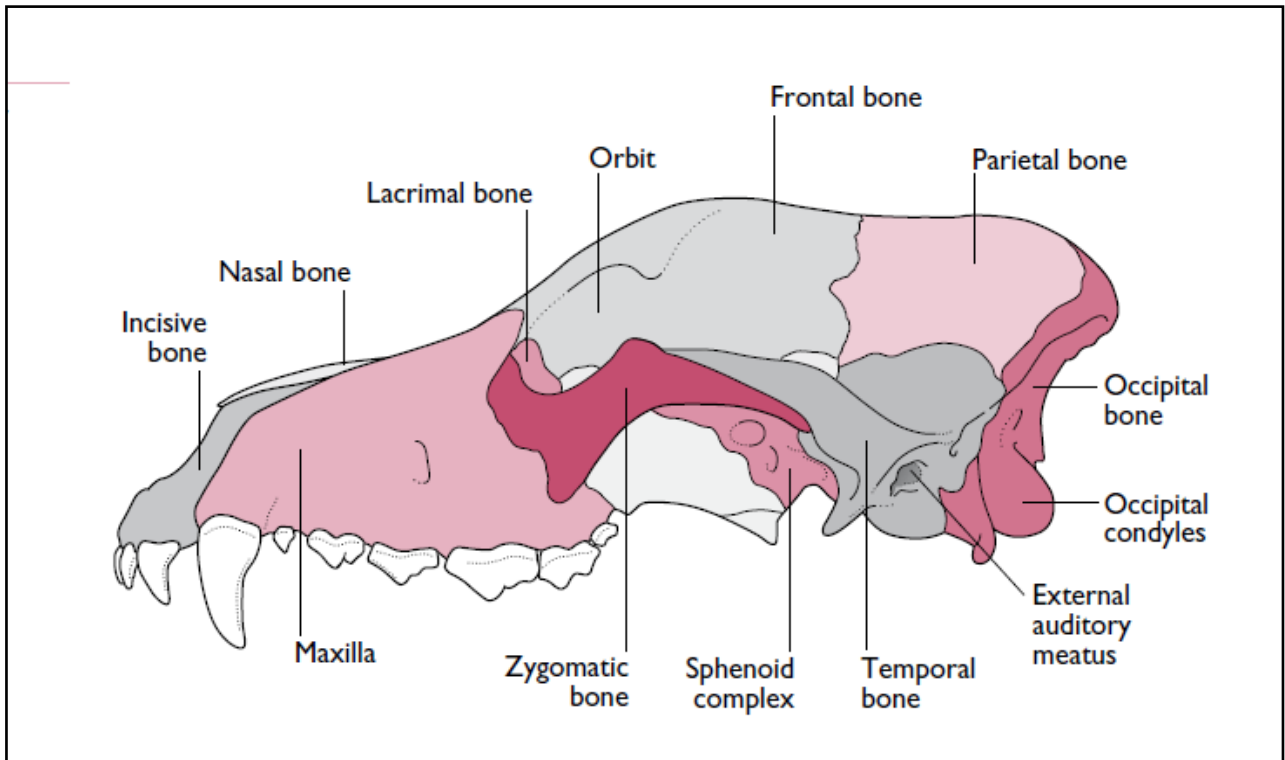
Fig. 5 Rib cage: showing sternal, asternal and floating rib

Sternum (Breast bone)

- It is a median segmental bone (sternebrae)
- Consists of series of sternebrae joined together by intersternal cartilages
- Consists of 6-8 bones (sternebrae) depending on species. (dog: 8, Ox/horse: 7 Fig: 6)
- Divided into 3 parts:
- Manubrium (manubrium sterni): most cranial part.

- Body: cylindrical in carnivores. wide and flat in ruminants
- Xyphoid process: Last sternebra. Thin and plate like.

Skull



In general, the word skull means all of the bones of the head. The head consists of:

1. Cranial bones: enclose the cranial cavity including brain, its meninges and blood vessels.
2. Facial bones: form the walls of the oral and nasal cavities and support larynx and root of the tongue.

Cranial bones

Paired bone	Unpaired bone
1. Parietal	1. Occipital
2. Interparietal	2. Sphenoid
3. Frontal	3. ethmoid
4. Temporal	

Facial bones

Paired bones	Unpaired bones
1. Maxilla 2. Premaxilla 3. Lacrimal 4. Zygomatic 5. Palatine 6. Pterygoid 7. Nasal 8. Turbinates/Conchae	1. Vomer 2. Mandible and 3. Hyoid

Bony cavities of the skull

Name of the cavity	Contents
1. Cranial cavity	Brain, its meninges and blood vessels
2. Nasal cavity	Vomero-nasal organ
3. Orbital cavity	Eyeball

Bones of the thoracic limb/Fore limb/Pectoral limb

Fore limb consists of 4 chief segments: Shoulder girdle, arm, forearm and manus.

1. Shoulder / Pectoral girdle: comprises 3 bones

- Coracoid
- Clavicle and
- Scapula (Shoulder blade)

Generally clavicle is absent (rudimentary/ vestigial) in the dog. The clavicle is normally present in the cat but does not articulate with other bones. In domestic mammals, the coracoid is reduced to coracoid process and fused to the medial side of the scapula.

2. Humerus (Brachium/arm)- single long bone

3. Radius and ulna (antebrachium/forearm)

4. Manus: Carpus, metacarpus and digit are collectively called manus.

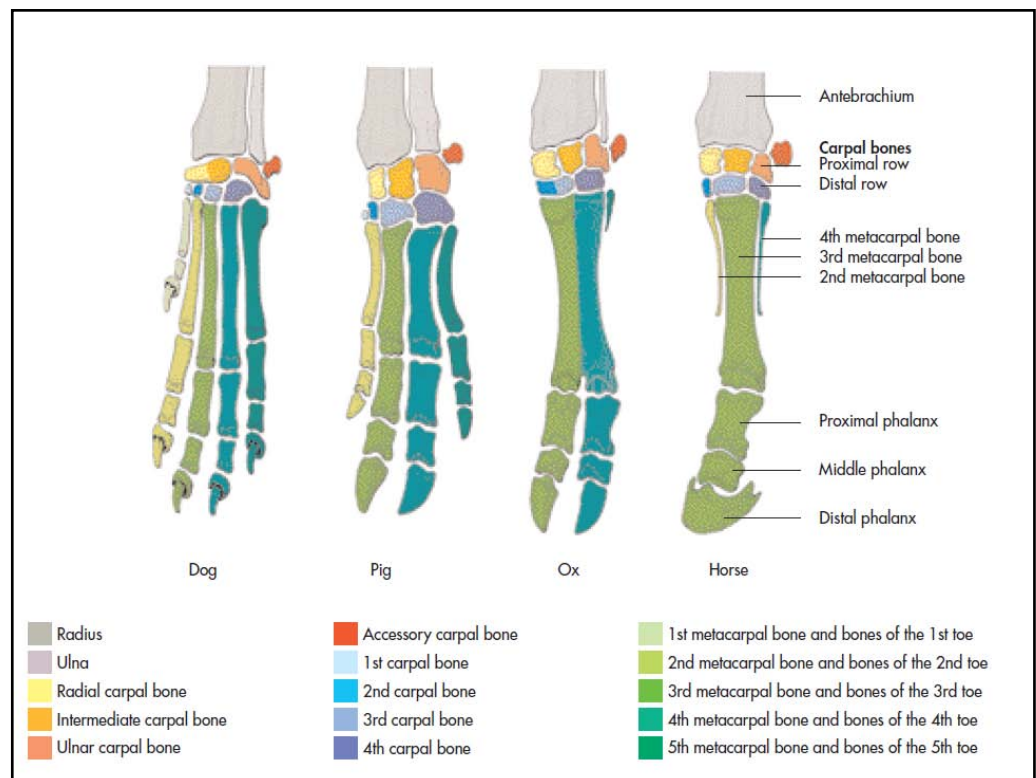
Carpus: Typically consists of 8 short carpal bones (In dog 7). Carpal bones are arranged in two rows: proximal and distal. Proximal row consists of radial, intermediate, ulnar and accessory (medial to lateral). The distal row is numbered in the same manner as 1st, 2nd, 3rd and 4th.

Metacarpus: Typically 5 small long metacarpal bones.

- ⇒ In dog and cat metacarpus composed of five small long bones. First metacarpal bone (MCI) is much smaller than the other metacarpal bones (II–V), and is non-weight bearing.
- ⇒ In ruminants, the metacarpal bone is the result from the fusion of the 3rd and 4th bones. The distal end of the bone is divided into two parts by a sagittal notch and each of which carries a digit.
- ⇒ Three metacarpal bones are present in horse. Among them only 3rd one is well developed and carries a digit. The other two, the 2nd and 4th are much reduced and are commonly called the small metacarpal or "splint bones“.

Digit: The digit or digits are the collective name of the first Phalanx, second phalanx & third phalanx.

- ⇒ In dog/cat, there are five digit
- ⇒ In pig, 4 digit
- ⇒ In ruminants, the 3rd and 4th are well developed and carries phalanges while 2nd & 5th are non-functional (small dew claws)
- ⇒ In horse, only one digit is



well developed (i.e. 3rd one). Two proximal sesamoid bones are situated at the proximal end of the first phalanx and one distal sesamoid bone is situated in between 2nd and 3rd phalanx and it is known as navicular bone.

BONES OF THE HINDLIMB

Hind limb or pelvic limb consists of 4 chief segments: Pelvic girdle, Thigh, Leg/crus, Pes

1. The pelvic girdle (Hip bone): consists of two symmetrical hip bones (called os-coxae) which meet ventrally at the pelvic symphysis. Each hip bone consists of following three bones:

- Ilium
- Pubis and
- Ischium

2. Thigh: Femur (thigh bone) - is a long bone and form the thigh.

Patella (Knee cap) - Largest sesamoid bone located in the muscle of the thigh.

3. Leg/Crus: Tibia and Fibula- form the Leg/Crus

4. Pes: tarsus, metatarsus and digit are collectively called pes.

Tarsus or hock: The tarsal bones are arranged in two rows: proximal and distal.

- ⇒ The tarsus of the ruminants consists of 5 tarsal bones.
- ⇒ In horse 6 and
- ⇒ In dog 7 tarsal bones.

Metatarsus (same as corresponding forelimb)

Digit (same as corresponding forelimb)



Fig. Word skeleton. The main bones of axial and appendicular portions of the skeleton