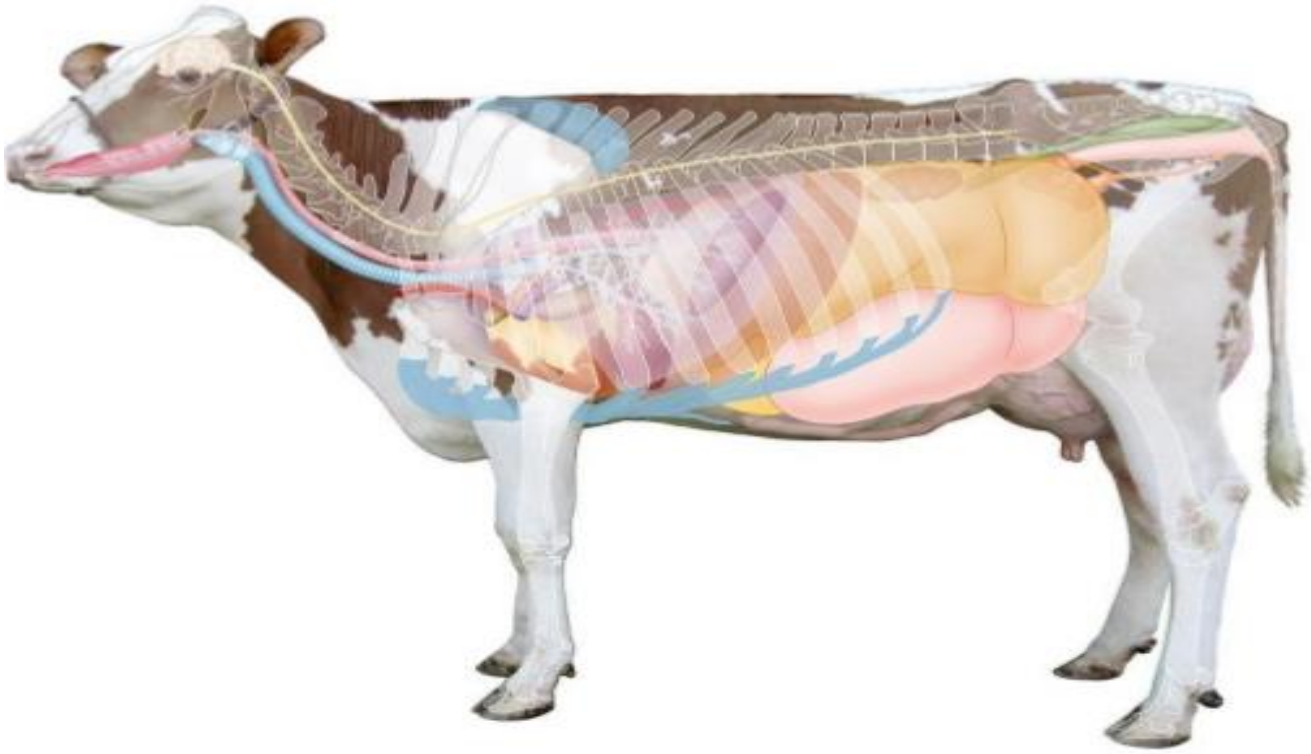
1. General introduction (Dr. Danjeres T)



Definition

Classification

Methods of study

Topographic terms

Definition

Anatomy is the branch of biological science deals with the form, disposition and structure of the tissues and organs that comprise the body. The word anatomy is derived from two Greek words:

- *Ana* -up/apart and
- *Tome*-to cut

} Cutting apart

Literally means "cutting apart", because the subject was studied by dissecting of a cadaver (a dead body).

Subdivision of anatomy

The science of anatomy has become so extensive that it is now divided into many specialized branches.

- **Microscopic Anatomy (Histology):** involves the study of finer details of an organism that can only be seen with the aid of microscope.
- **Macroscopic (Gross) anatomy:** involves the study of the form and relations (relative positions) of body structures that can be seen with unaided eye.
- **Developmental anatomy:** is the study of the changes which organism undergoes during their development. Or Studies the stages through which an organism evolves from conception (fertilization of the egg) through birth (embryology), and to youth maturity and old ages (ontogeny)**.**
  - Two kinds of development:
    I. Ontogeny - development of an individual from conception to adult hood and old (complete life history).
    II. Phylogeny - development of certain types of species from earlier prehistoric origin to the present time (ancestral history).

- **Comparative anatomy:** is the description and comparison of structures between different species of the animals with particular emphasis on those characteristics that aid in classification. It forms the basis for their classification and shows the genetic relations of various groups of animals.
- **Special anatomy:** describes a single species of animal or a single body tissue (system) of an organism. Example, Human anatomy, Veterinary anatomy

✓ **Veterinary anatomy:** deals with the form AND structure of the principal domesticated animals.

METHODS OF STUDYING ANATOMY

Two chief methods are employed for the study of anatomy:

A number of methods have been developed for the study of anatomy. The following are presently employed:

A. Systemic anatomy
B. Regional (topographic) anatomy

A. **Systemic anatomy:** study groups of organs or systems of the body that are similar in origin and structure and are closely related in their activities or are associated in the performance of certain functions.

❖ The divisions of systemic antomy are:

1. Osteology: the description of the skeleton (bone and cartilage)
2. Syndesmology (Arthrology): the description of the joints
3. Myology: the description of the muscle and accessory structure
4. Splanchnology: the description of the viscera
    - Digestive system
    - Respiratory system
    - Urogenital system
        - Urinary organ
        - Genital (reproductive) organ
5. Neurology: the description of the nervous system
6. Angiology: the description of the organs of circulation (e.g. heart, blood vessel, lymphatic and spleen)
7. Aesthesiology: the description of the sense organs and common integument
8. Endocrinology: the description of the ductless gland
9. Cardiology
10. Angiology (Cardio-vascular system)

B. **Regional (topographic) anatomy:**

- Regional (or topographical) anatomy is directly concerned with the form and relationships of all the organs present in particular portions or regions of the body.
- The body is normally divided in to four arbitrary regions:
    1. Head & neck
    2. Thorax & forelimb
    3. Abdomen, and
    4. Pelvic region & hind limb
- Important for clinical works

Topographic terms

Topographical terms are used to indicate the precise position and direction of parts of the body. In explanation of these terms, it is to be assumed that they apply to a quadruped (four-legged) animal in an ordinary standing position. Many terms of direction differ significantly between human and domestic animal anatomy because of the orientation of bipedal versus quadrupedal stance.

1. **Body planes (planes of reference)**
2. **Directional and positional terms**

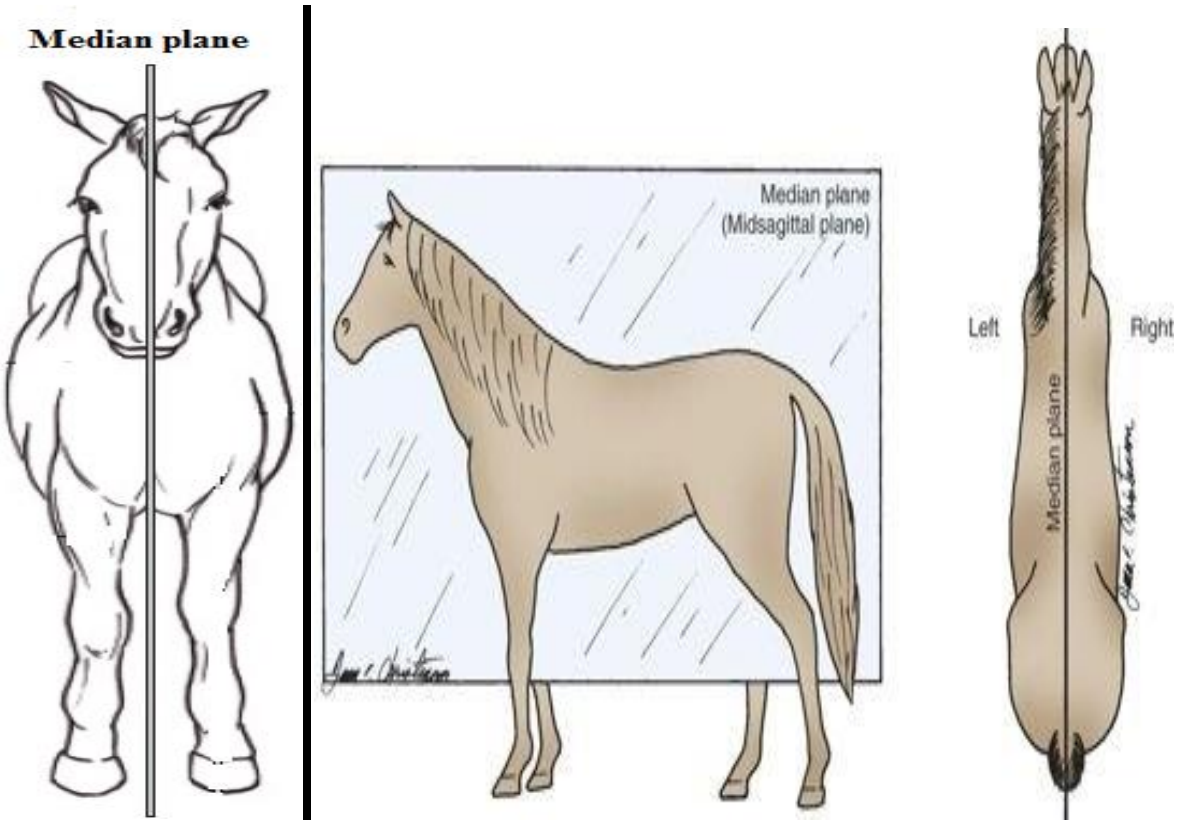
1. Body planes (planes of reference)

In describing an animal's body, four arbitrary planes of reference have been used to locate parts and structures. These planes are located in reference to the long axis of the body. Long axis is an imaginary line that passes through the center of the spinal column. The planes of reference are:

I. Median plane
II. Sagital plane
III. Transverse (segmental) plane
IV. Frontal plane

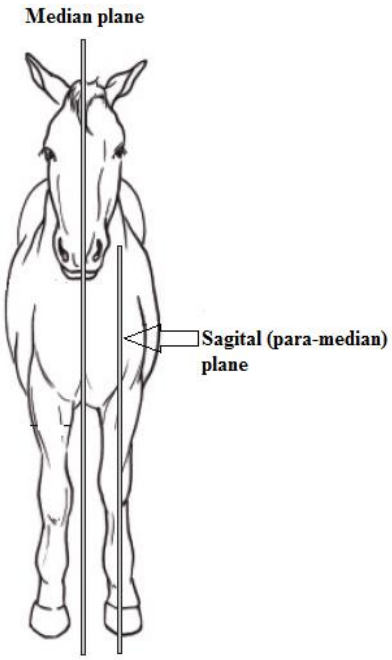
I. Median plane: Latin – medius ⟶ middle

- It passes through the center of the long axis of the body and divides the body in to two equal left and right halves.
- It also called longitudinal or Mid-sagital plane
- The primary reference of the body, the other planes are constructed in relation to the medial plane.



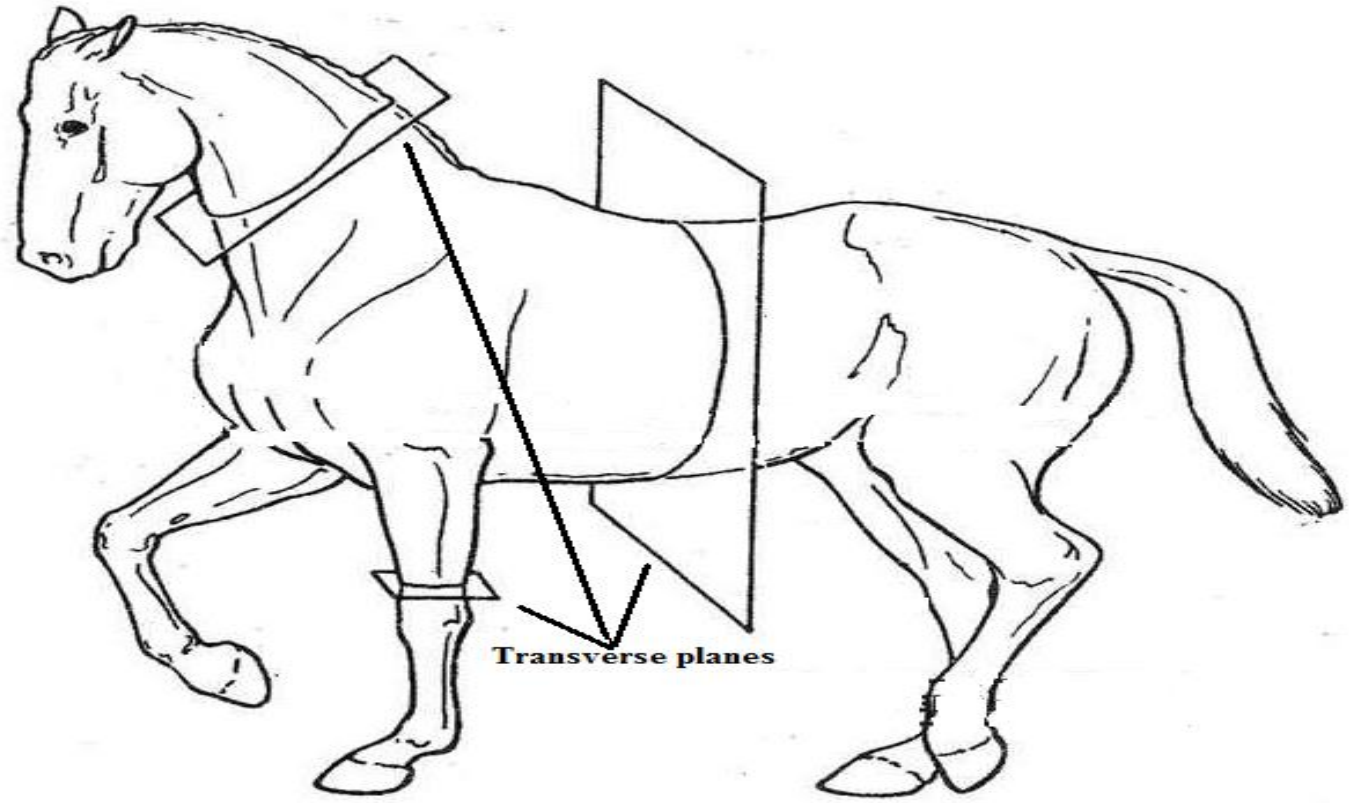
II. Sagital plane

- It is any plane parallel to the median plane but doesn't pass through the long axis. Or the plane passes through the head, body or limb parallel to the median plane.



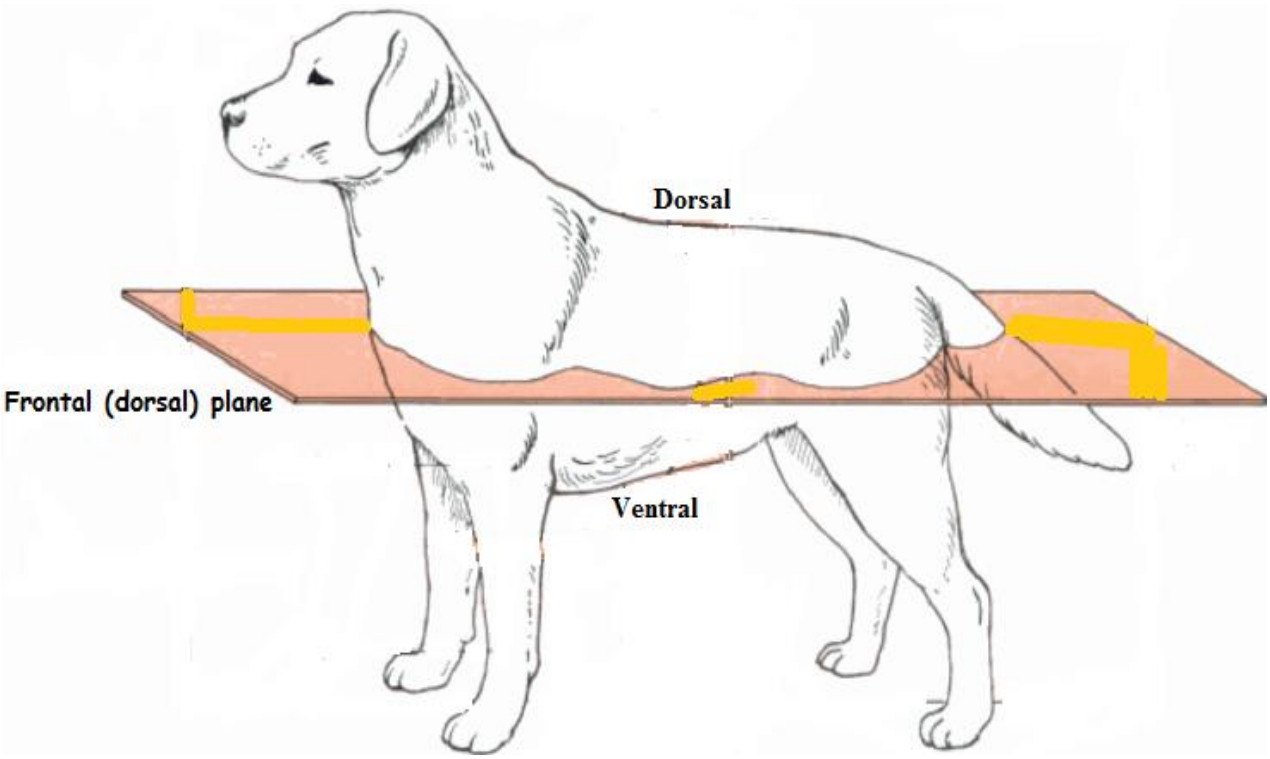
III. Transverse or segmental planes

- Are the planes that cut across the long axis of the body perpendicular (at right angles) to the medial plane, or cuts across the head, an organ or limb at right angles to its long axis.
- Divides the bodies cross sectional in to cranial (head-end/anterior) and caudal (tail-end/posterior) portions, but those are not necessarily equal.
- But cross section of most animals' limbs will be cut by frontal planes.



IV. Frontal (dorsal)

- It is a plane that passes parallel to the dorsal surface at right angle to the median and transverse planes.
- It divides the body into dorsal (back/upper) and ventral (belly/lower) portions that are not necessarily equal.
- It is also called dorsal or horizontal plane



Positional and directional terms

A term that describe the position and direction of certain organ or structure of body part relative to another. Body planes are used as a reference to give directional terms and they are arranged in pairs in the opposite sense (Dorsal Vs Ventral, Cranial Vs Caudal, Medial Vs Lateral, and Proximal Vs Distal).

1. **Ventral**: indicate a relative location towards or near the belly (venter) or a surface directed toward the plane of support (ground) or towards lowermost surface of the body and the corresponding surfaces of the head neck and tail.

Example: - Intestine is ventral than kidney

- The udder is the most ventral part of the body
- The tongue is ventral to the nasal cavity

2. **Dorsal**: the opposite surface to the preceding (i.e. towards the back (dorsum) of the trunk or relatively near to the top of the head, neck and tail).

Example: - The kidneys are dorsal to the intestines (kidney is more dorsal than intestine)

- A saddle is placed on the dorsum of a horse.
- The backbone is dorsal to the belly

3. **Medial or internal**: a surface or structure which is pertaining to (nearer than another) to the median plane (i.e. towards or relatively near to the median plane).

Example: - The heart is medial to the lungs; it is closer to the median plane than are the lungs.
- The chestnut is on the medial aspect (inside) of a horse's limb; it is on the side closest to the median plane.
- The bladder is medial to the hips

4. **Lateral or external**: a surface or structure which is further from the median plane (i.e. away from or relatively further from the median plane).

Example: - The ribs are lateral to the lungs, that is, farther from the median plane.
- The shoulder is lateral to the ribs

5. **Cranial (anterior): for** a surface or structures that lie towards or relatively near to the head (cranium, literally skull). Anterior is substituted for the cranial in the eye.

Example: - The shoulder is cranial to the hip i.e. it is closer to the head than the hip.
- The neck is cranial to the tail
- The diaphragm is cranial to the stomach

6. **Caudal (posterior)**: a surface or structures that lie towards or relatively near to the tail head (cauda). Posterior is substituted for the caudal in the eye.

Example: - The rump is caudal to the loin.
- The ribs are caudal to the neck

7. **Rostral and caudal:** are used within the head or in reference to features of the head, structures toward the nose or muzzle (rostrum) are said to be *rostral;* toward the tail (caudal).

Example: - There are more grey hairs in the rostral part of the head
- The nose is rostral to the ear

Terms applied to the limbs

8. **Proximal** (proximus, near): refers to those parts of the limb or limb structures that are nearest to the long axis of the body or main mass of the body or point of origin of a limb.

Example: - The carpus or knee is proximal to the foot.
- The shoulder is proximal to the elbow
- The elbow is proximal to the digit.
- The humerus is proximal to the radius

9. **Distal** (distantia, distance): refers to those parts of the limb or limb structures that are furthest away from the long axis of the body or main mass of the body or point of origin of a limb.

Example: - The hoof is distal to the carpus or knee.
- The carpus is distal to the elbow
- The ankle is distal to the knee

With reference to the thoracic limb (pectoral limb) or forelimb

✓ **Dorsal**: refers to the cranial face of the thoracic limb (forelimb) distal to and including the carpus (knee).

✓ **Palmar**: refers to the caudal face of the thoracic limb (forelimb) distal to and including the carpus (knee). The "walking" surface of the front (fore) paw

Example: - The dew claw of the ox is on the palmar surface of the forelimb

With reference to the pelvic limb or hindlimb

✓ **Dorsal**: refers to the cranial face of the pelvic limb (hindlimb) distal to and including the tarsus (hock).

✓ **Plantar**: refers to the caudal face of the pelvic limb (hindlimb) distal to and including the tarsus (hock). The "walking" surface of the hind paw

Terms to indicate relative distances from the centre of the limb (axis of the limb)

✓ **Axial:** pertaining to or being relative (close) to the longitudinal axis of a limb.

Example: - The AXIAL SURFACE of a digit faces the axis
- The inside of a digit is the side

✓ **Abaxial:** further or away from the longitudinal axis of a limb.

Example: - The outside of a digit is the Abaxial side

Terms to indicate relative distances from the surface of the body

✓ **Superficial**: relatively near to the surface of the body, or to the surface of a solid organ.

Example: - The biceps brachii muscle is superficial to the humerus

✓ **Deep**: relatively near to the centre of the body or the centre of a solid organ.
- Farther from the surface of the body, or from the surface of a solid organ

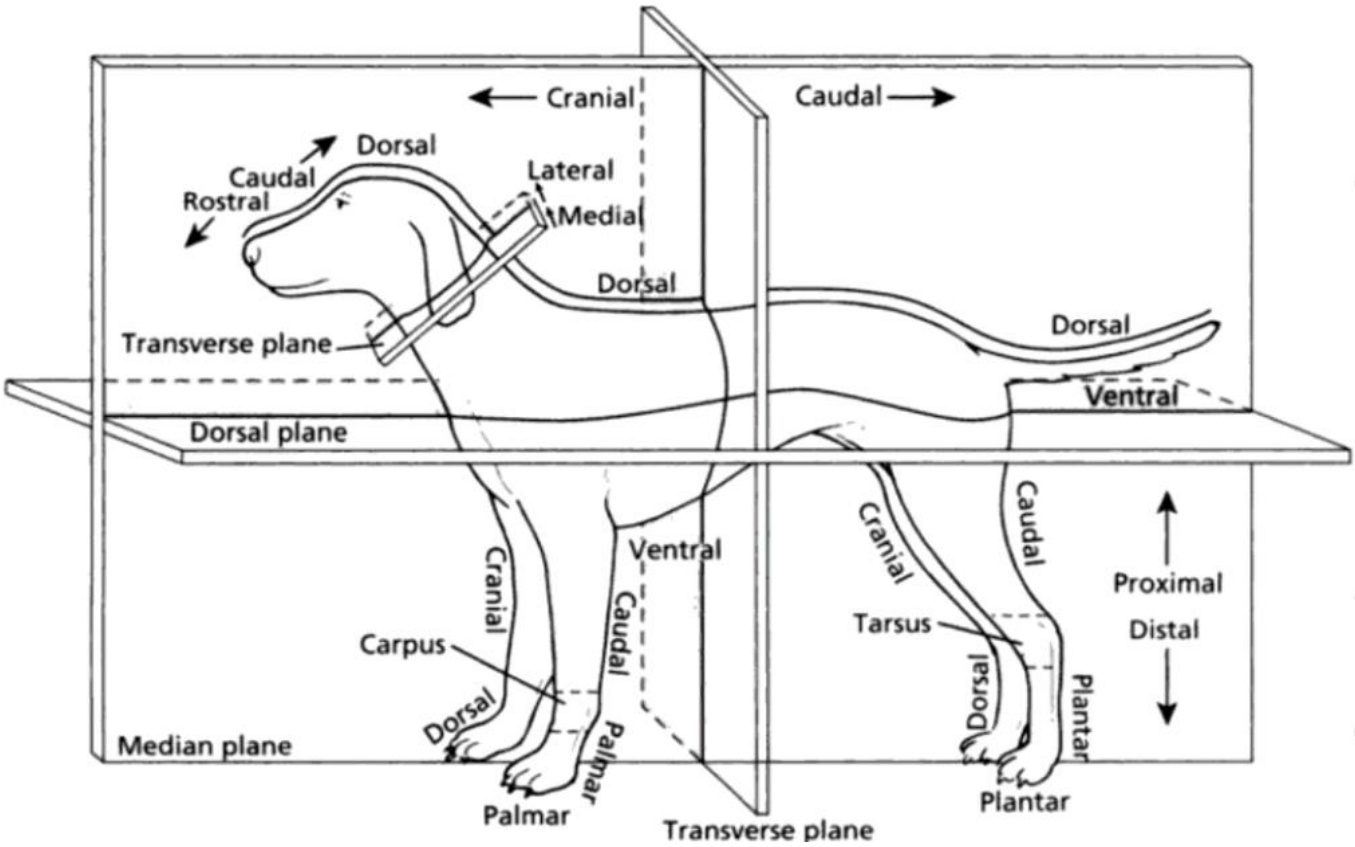
Example: - The femur is deep to the thigh muscle

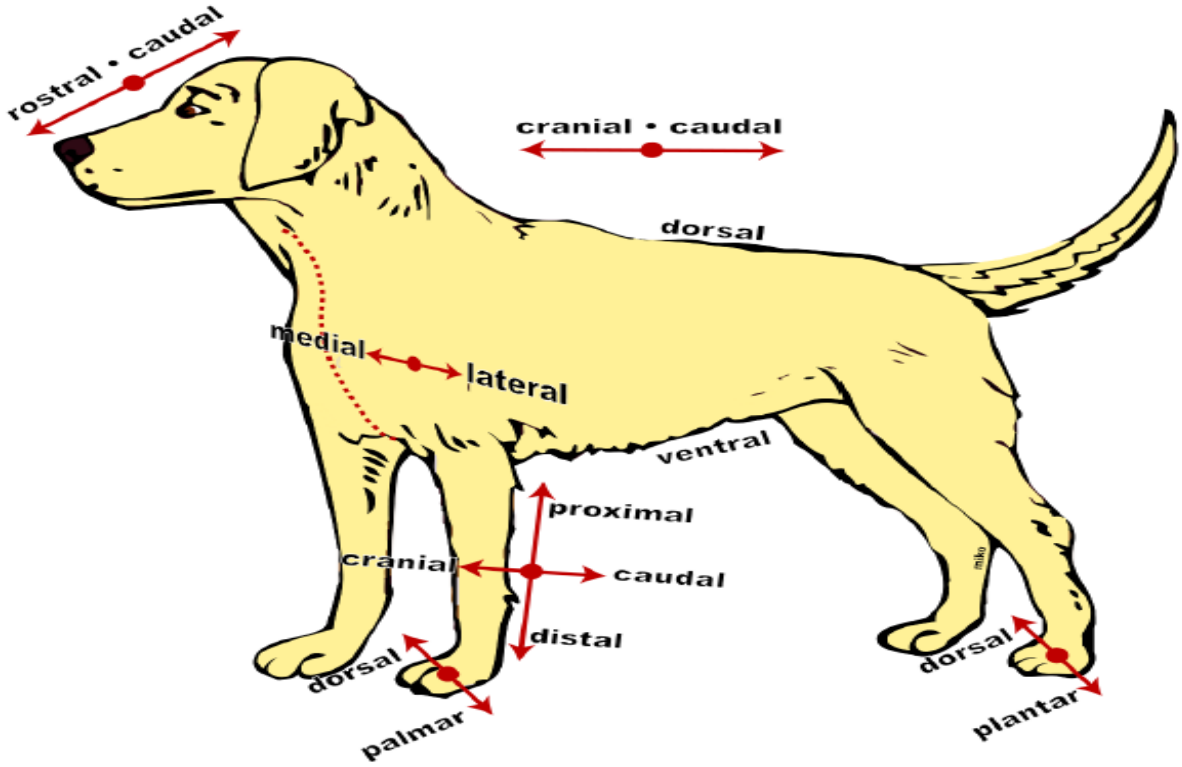
- ✓ **External or outer**: closer to the outer surface of a structure or away from the centre of a hollow organ.

Example: - Capsule is external to the kidney

- ✓ **Internal or inner**: closer to the center of a structure; or close to, or in the direction of the centre of a hollow organ

Example: - The medulla is internal to the cortex

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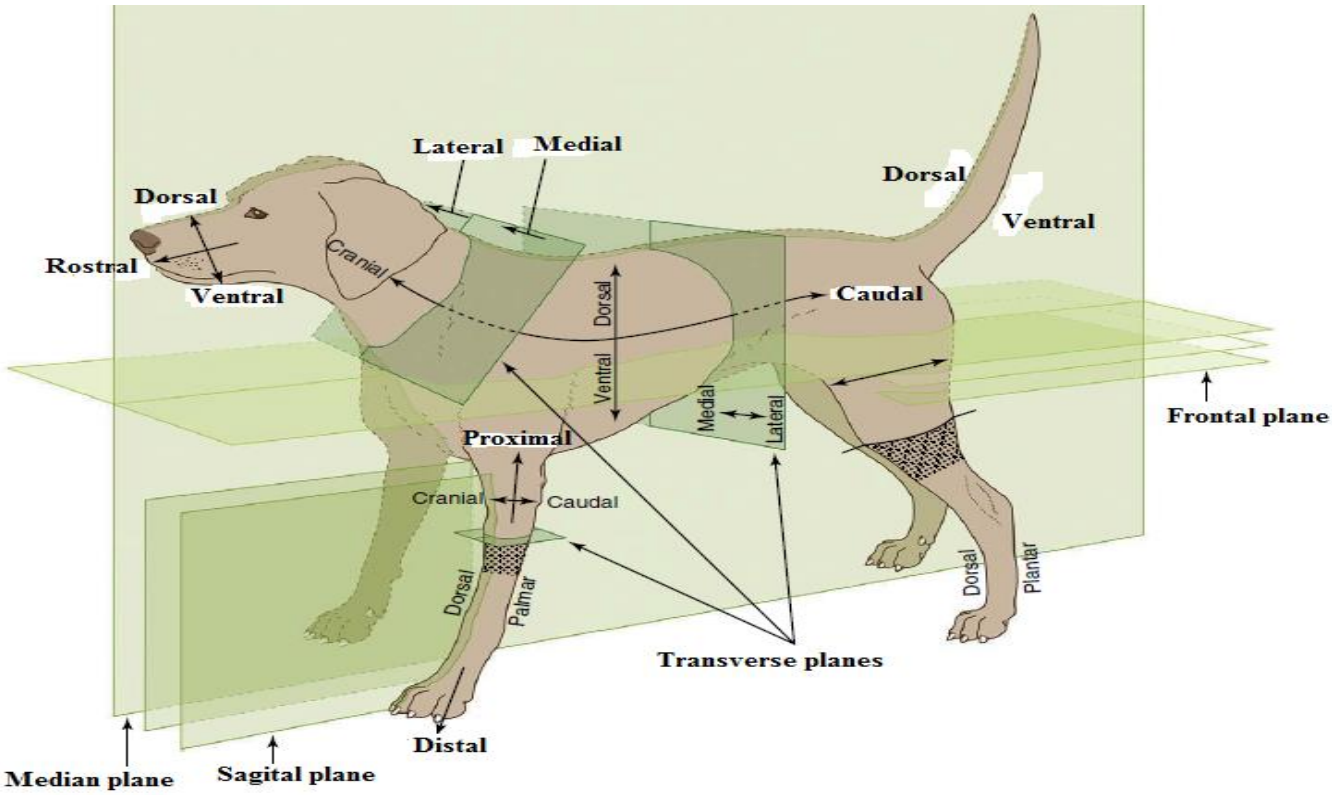
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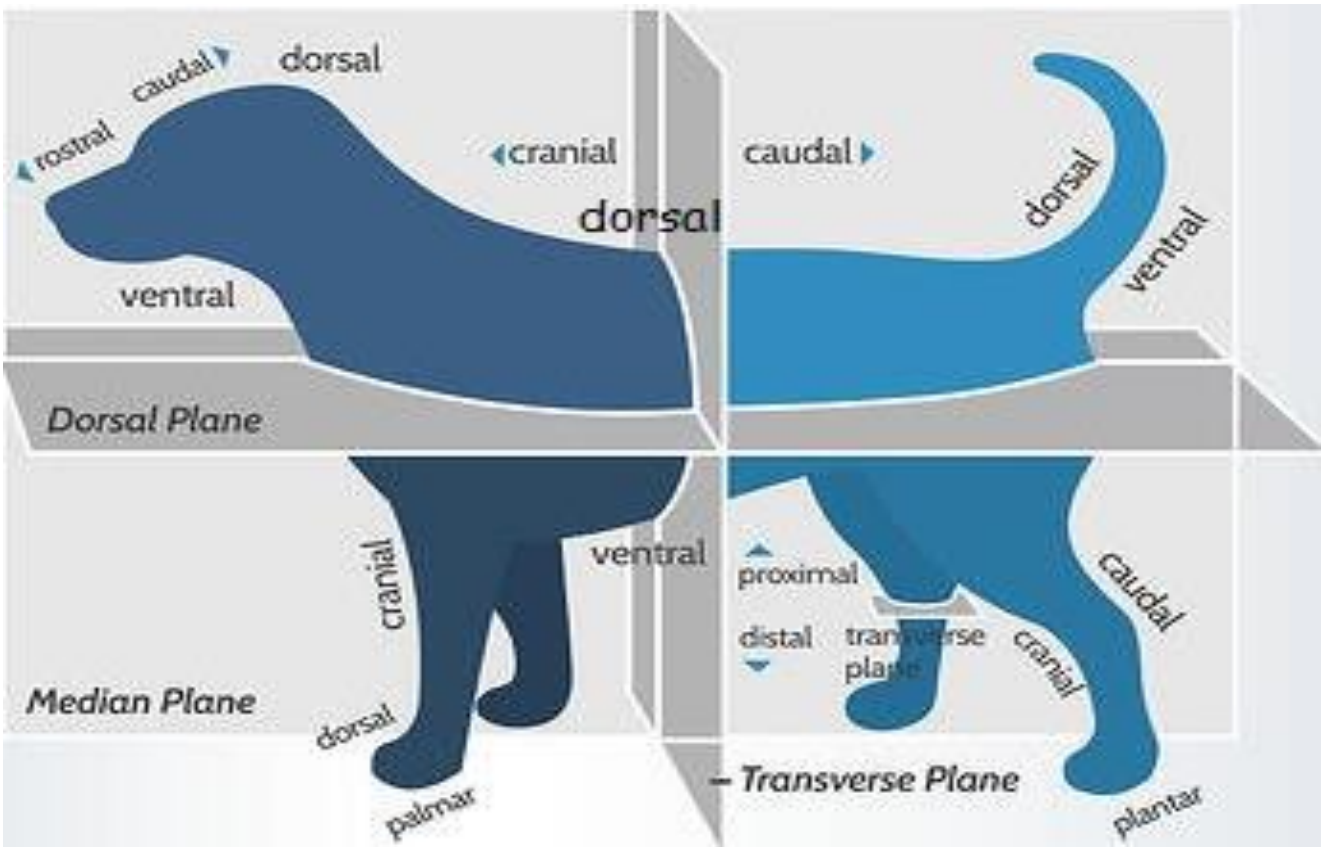
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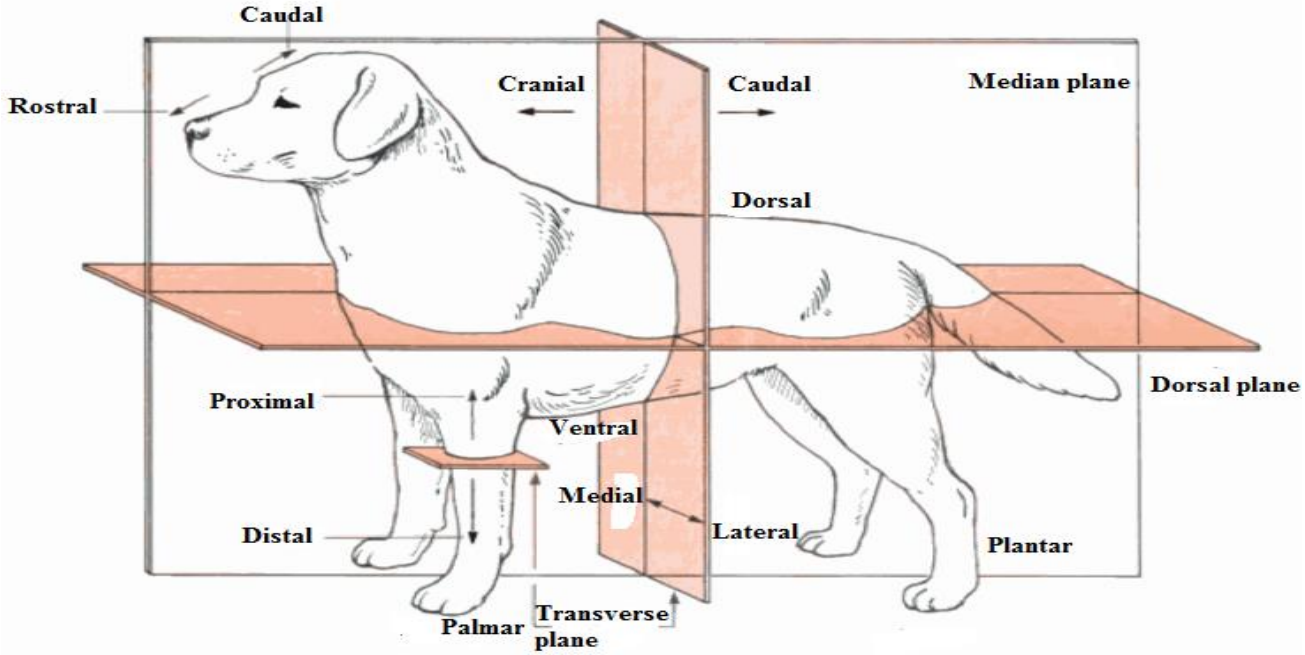
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2. OSTEOLOGY

Objectives: At the end of this lessons, you should have to know the following concepts:

- Bone and its structures
- Anatomical terms of depressions and projections
- Classification of bones based on its shape &
- Regional classification of bones

PLATE 2.4 Skeleton of the ox. Left lateral view. C = cervical vertebra, T = thoracic vertebra, L = lumbar vertebra, b = bone

- **Osteology** is the study of bones which make up the skeleton or framework of the body.
- The term **skeleton** is applied to the framework of hard structures which supports and protects the soft tissues of animals (bone and cartilage).
- It gives a basis for the external structure and appearance of most vertebrate animals as we know them.
- All mammals share a basic body plan with striking similarities in skeletal structure.
- Differences reflect adaptations to specific lifestyles (in different spp.) and developmental stage (within the same spp.).

- Even in adults of the same species numerical variations occur, e. g., the tarsus of the horse may consist of six or seven bones, and the carpus of seven or eight.
- **Bones** are living structures, it is supporting connective tissue.
- **The following are some properties of bones**

✓ They have blood vessels, lymphatic vessels, and nerves.

✓ they are subject to disease.

✓ they can undergo repair and

✓ they adjust to changes in stress (has high tensile and compression strength).

❖Function of bones

- ✓ Providing protection for vital organs.
- ✓ Giving rigidity and form to the body.
- ✓ Serves as levers for movement and attachments of muscles.
- ✓ Storage site for minerals (**Ca^{+2} & $PO4^{-2}$).**
- ✓ Site for blood cells formation (**bone marrow).**

Composition of bones

- ➢ Organic matters (1/3):- collagen fiber, glycos-aminoglycans (GAGs) and cells which give resilience and roughness for bones.
- ➢ Inorganic matters(2/3):- salts ($CaPO4^{-2}$ (80%),$CaCO_3$, $MgCO_3$). They give hardness of bones

Vascular supply of bones

a. Arteries

- Bones generally have a rich and redundant blood supply.
- It gets blood through at least one of the following three ways:

- **Periosteal Arteries**:- in the vascular (deepest) layer of the periosteum penetrate and supply the cortical bone.
- **Nutrient Artery/arteries**:- one or more major vessels which penetrate the cortical bone via a nutrient foramen to supply the spongy bone and marrow and the cortex.
- **Epiphyseal Arteries:-** supply the epiphyses and epiphyseal plates of bones critical to the health of the epiphyseal plate and the growth of bones.

b. Veins - accompany the arteries and have the same names.

c. Lymphatics - accompany periosteal vessels but presence within bone is uncertain.

Gross structures of bones

- The architecture of bone can be studied best by means of longitudinal and cross-sections.

In longitudinal section bone consists of:

a. Compact bone: An external shell of dense compact substance, within which is the more loosely arranged spongy substance.

- In the **long bones** it is thickest in the middle part of the shaft and thins out toward the extremities.
- In **short bones**, it's very thin, and is especially dense and smooth on *joint surfaces*.

b. The spongy substance: consists of delicate bony plates and spicules which run in various directions and intercrosses and forms **porous network**.

A numerous small cavities formed in between this network is called *trabeculae.*

- It forms the bulk of short bones and extremities of long bones.
- The spaces are usually filled with marrow.

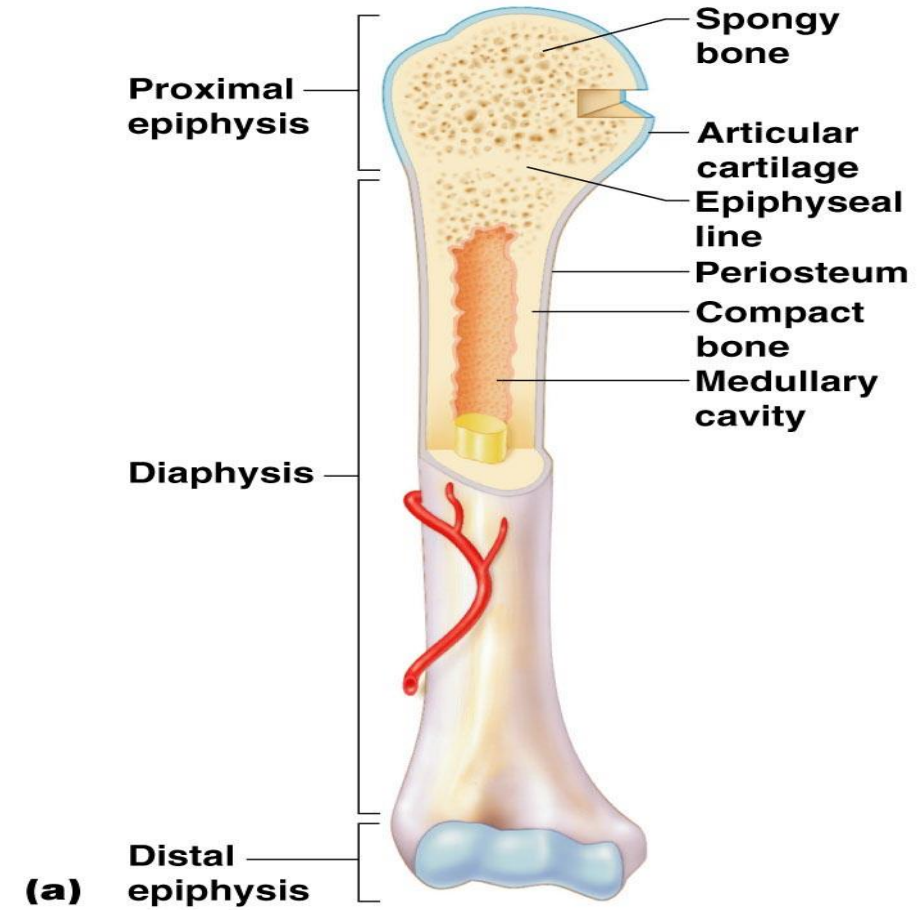
c. Medullary cavity (marrow cavity): is the space surrounded by the cortex of a long bone.

- ✓ In young animals filled with ***red marrow***
- ✓ In old animals replaced by ***yellow marrow (fat)***

d. Periosteum is the membrane which invests the outer surface of bone, except where it is covered with cartilage.

- It consists of an outer protective fibrous layer, and an inner cellular osteogenic layer.
- Responsible for increases in the diameter of bones, and activity of periosteal cells is important in the healing of fractures.
- The periosteum has vascular and well-innervated, so the one way through which bone tissue get blood supply and innervated.
- It is desiccated in dead old bones.

e. Endosteum - thin layer of bone forming and resorbing cells lining the internal surfaces of bones, i.e., the walls of the marrow cavities and the surfaces of the trabeculae.



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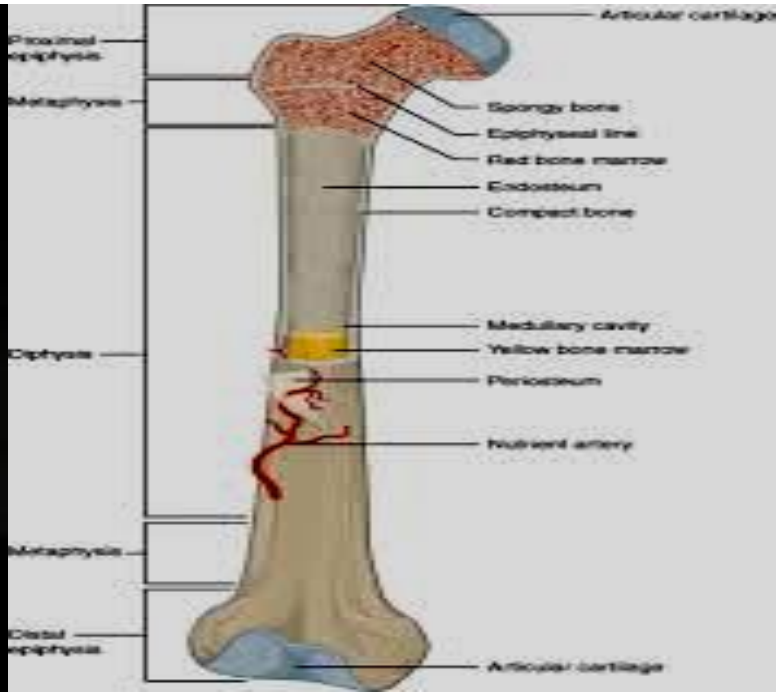
Morphological and Functional Classification of Bones

A. Long bones: are typically of elongated cylindrical form with enlarged extremities. They occur in the limbs, where they act as supporting columns and as levers.



Structurally the long bone consists of

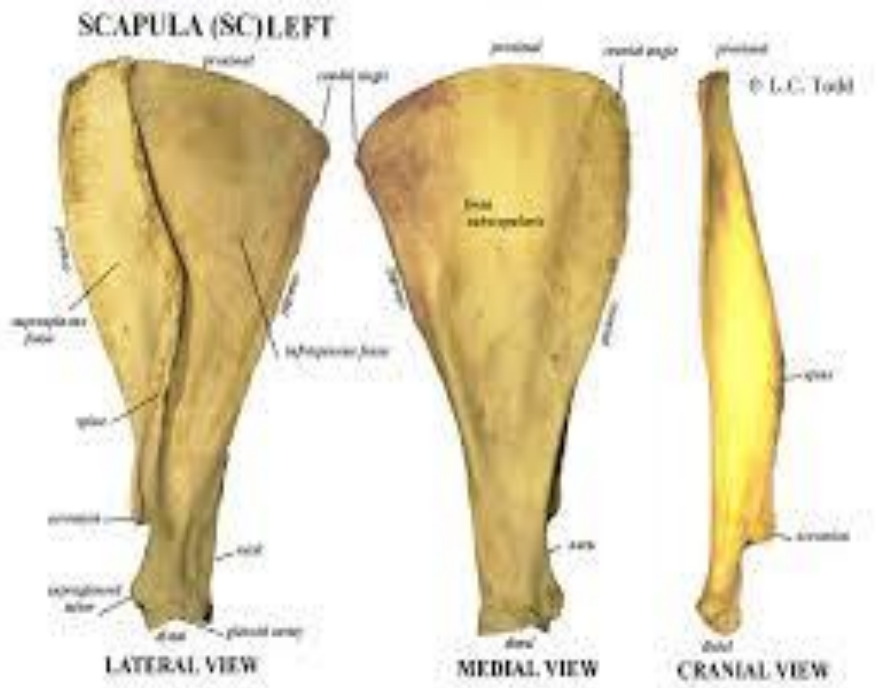
- **Epiphysis** refers to either end of a long bone. The end closest to the body is the proximal epiphysis, and the end farthest from the body is the distal epiphysis.
- **Diaphysis** is the cylindrical shaft of a long bone between the two epiphyses.
- **Metaphysis** of a mature bone is the flared area adjacent to the epiphysis.
- **Epiphyseal cartilage or disk (physis)** 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.

B. Short bones: are cuboid, or presents approx. equal dimensions in length, breadth & thickness.

- There is no single marrow cavity, but the interior is composed of **spongy bone** filled with marrow spaces. The exterior is formed by a thin layer of compact bone.
- Best examples are **carpal** and **tarsal bones.**
- And their chief function appears to be that of diffusing concussions and absorb shock.

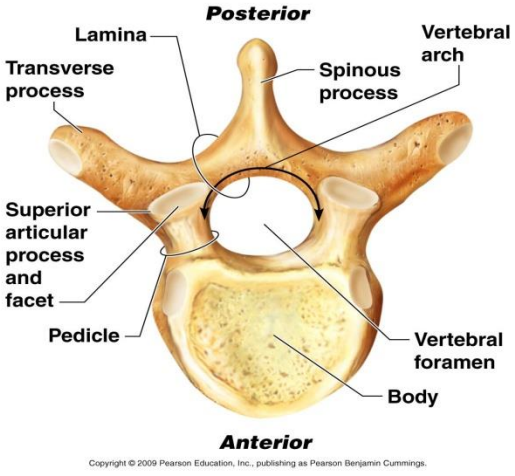
C. Flat bone: are relatively thin and expanded in two dimensions.

- They consist of two plates of compact bone, the **lamina externa** and **lamina interna**, separated by spongy material called **diploe**.
- They furnish sufficient area for the attachment of muscles and afford protection to the organs which they cover. E.g. skull, ribs, scapula, pelvic bones.



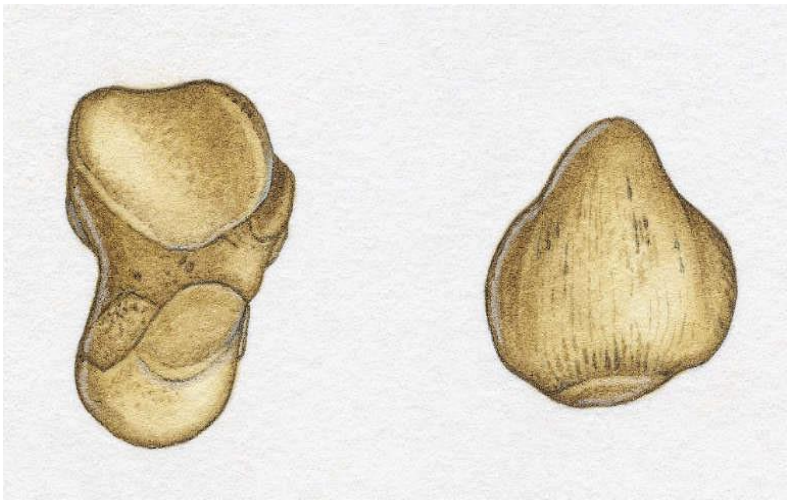
D. Irregular bone: These includes bones of irregular shape; mostly short and has multiple processes.

- They include unpaired bones on the median plane (vertebrae) and some unpaired bone of the skull.
- Serve for protection, support and muscle attachment.

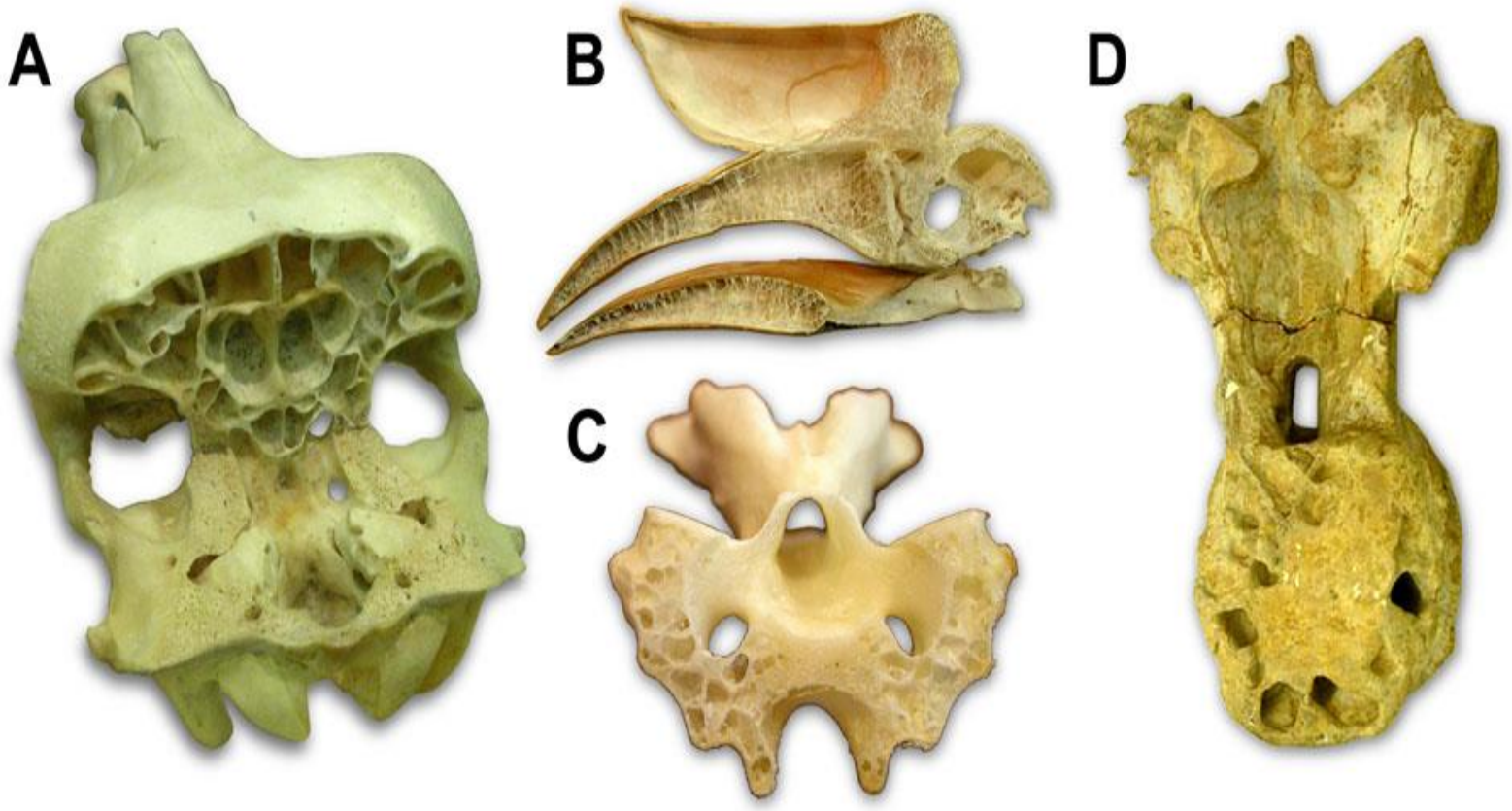


E. Sesamoid bones: called because of they imaginary resemble a ***sesame seed***.

- Sesamoid bones occur along the course of tendons and in capsules of some joints.
- It used to reduce friction, increase leverage, or change the direction of tendon pull's.
- The **patella** (kneecap) is the largest sesamoid bone in the body.



F. Pneumatic bone:- contain air spaces (sinus) that communicate with the exterior. E.g. the frontal and maxillary bones.

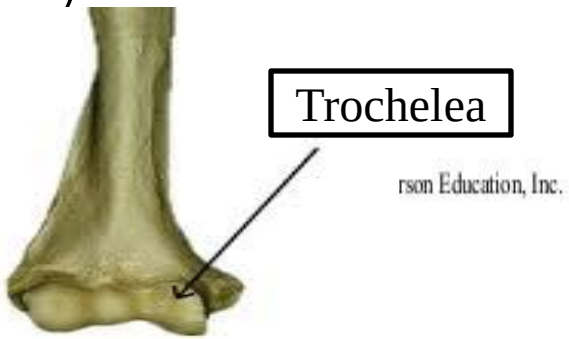


Descriptive terms for the surface of bones

- The surfaces of the bones present a great variety of eminences/prominence (projections) and depressions as well as perforations.
- They furnishing attachment to muscles, tendons, ligaments or fascia.
- The prominences (projections) and cavities (depressions) may be **articular**, or **non articular**.
- **Articular projection or depression-** give projectile or depressed surfaces for opposite depression or projection respectively, to form joints.
- **Non articular projection/depression** not associated with joints, rather for attachments of tendons, muscles, ligaments; e.g., fossa on the lateral surface of scapula.

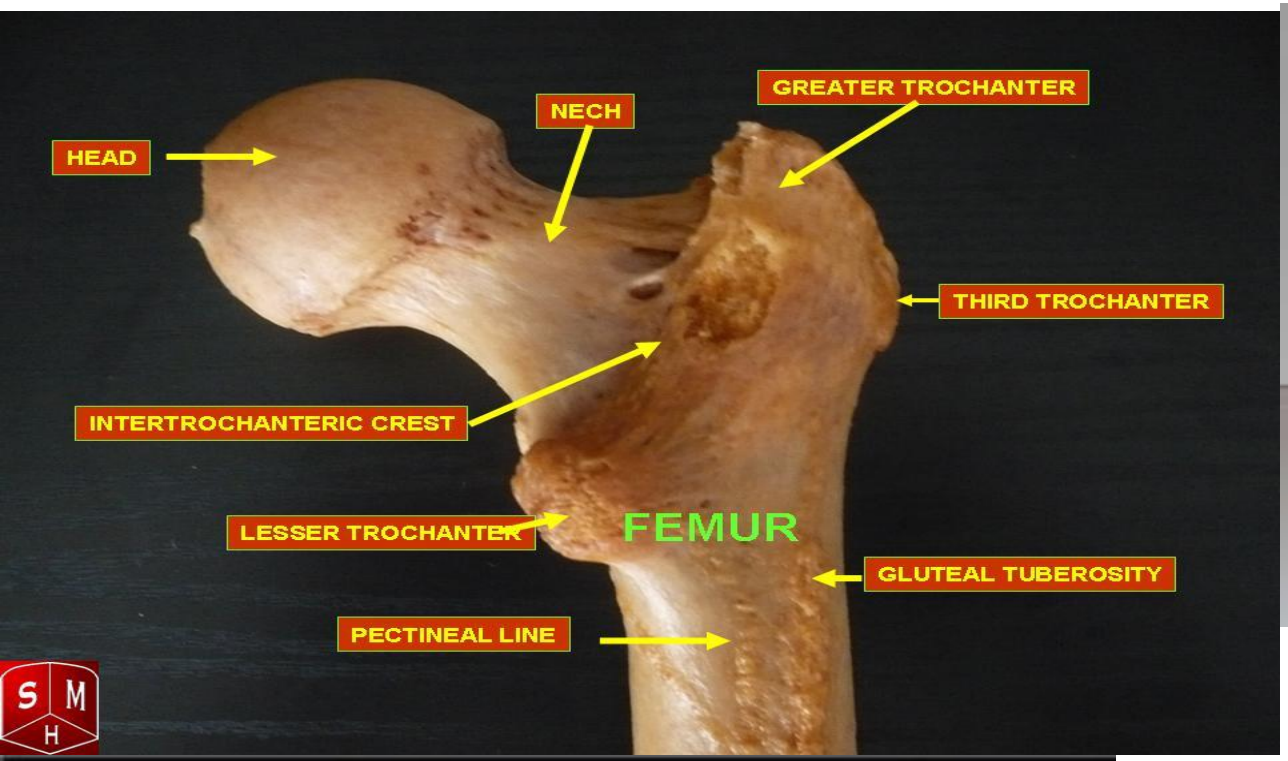
A. Articular projections:

- **Head**:- spherical articular projection at the end of a bone
- **Condyle**:- more or less cylindrical/ovoid articular eminences.
- **Trochelea**:- is condyle having pully like articular mass.
- **Facet**:- small, relatively flat articular surface.



B. Non articular projection

- **Process**:- general term for a bony projection.
- **Tuberosity (tuber)**:- is relatively large knoblike non articular projection.
- **Tubercle**:- relatively a smaller knoblike non articular projection.
- **Trochanter**:- large irregularly shaped process (found only on the femur).
- **Epicondyle**:- raised area on or above a condyle.
- **Spine**:- is sharp or a pointed projection.
- **Crest**:- is a term of a sharp ridge.
- **Neck**:- a cylinderical part of the bone to which a head is attached.
- **Line**:- is a small ridge or mark on a bone.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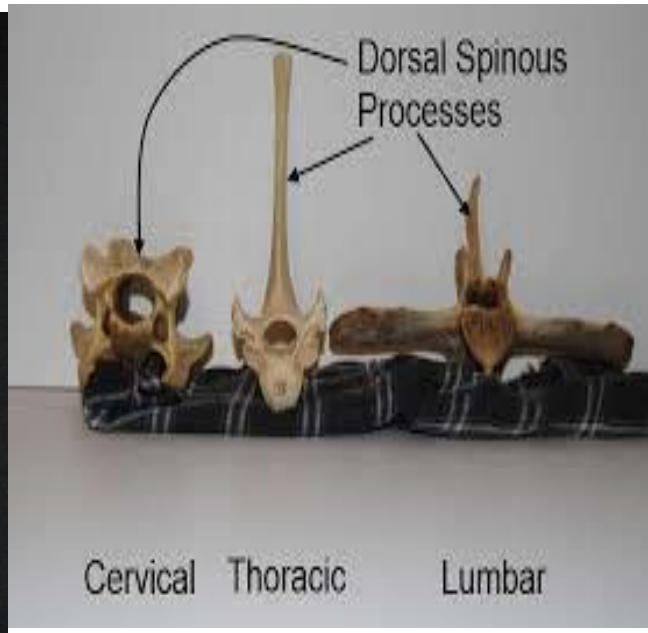
PECTINEAL LINE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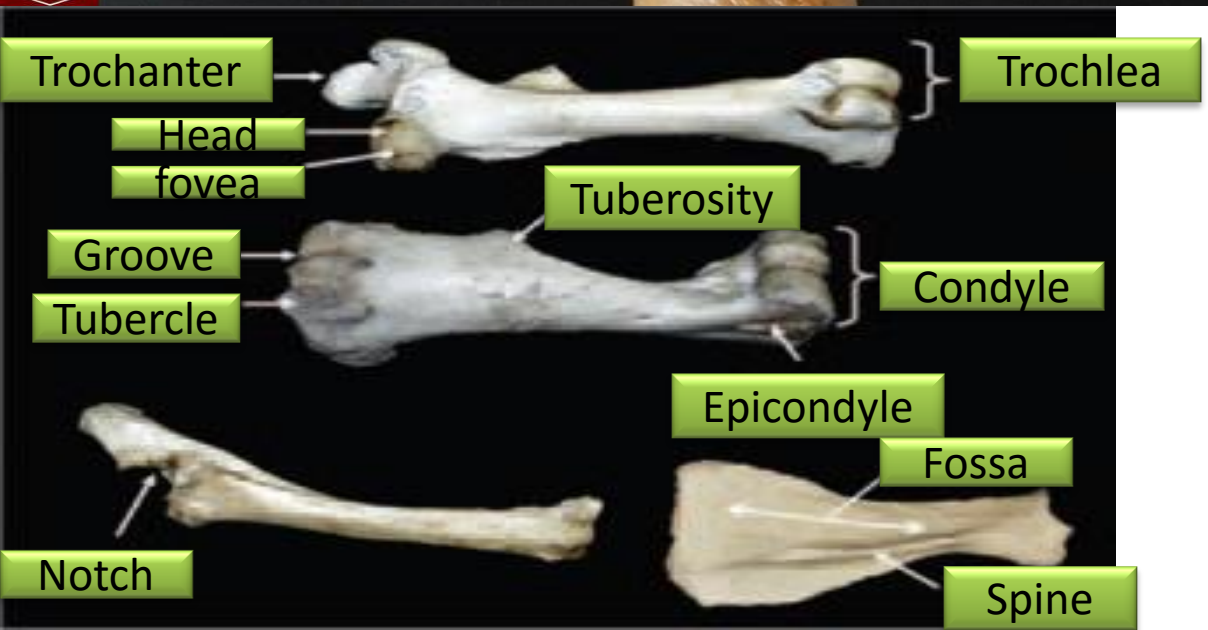

Trochanter
Trochlea
Head
fovea
Tuberosity
Groove
Condyle
Tubercle
Epicondyle
Fossa
Notch
Spine

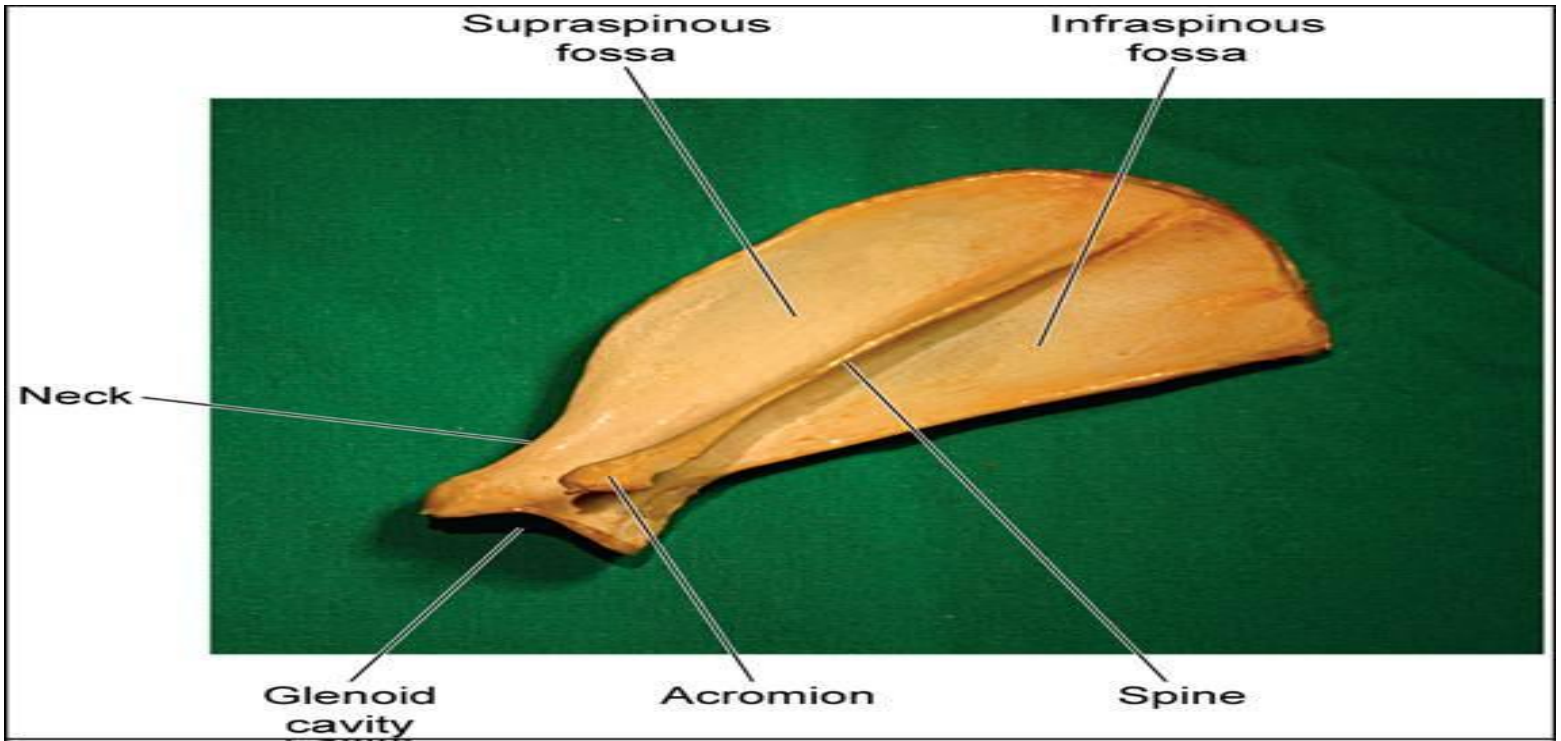
C. Articular depression

- **Glenoid cavity**:- a shallow articular concavity
- **Cotyloid cavity** :- a deep articular concavity
- **Notch**:- an articular indentation (hollowed out place such as an edge, boundary line, or coast)

D. Non articular depression

- **Sinus or atrum:** is air cavity within the bone e.g. nasal sinus
- **Fossa**:- large non articular depression

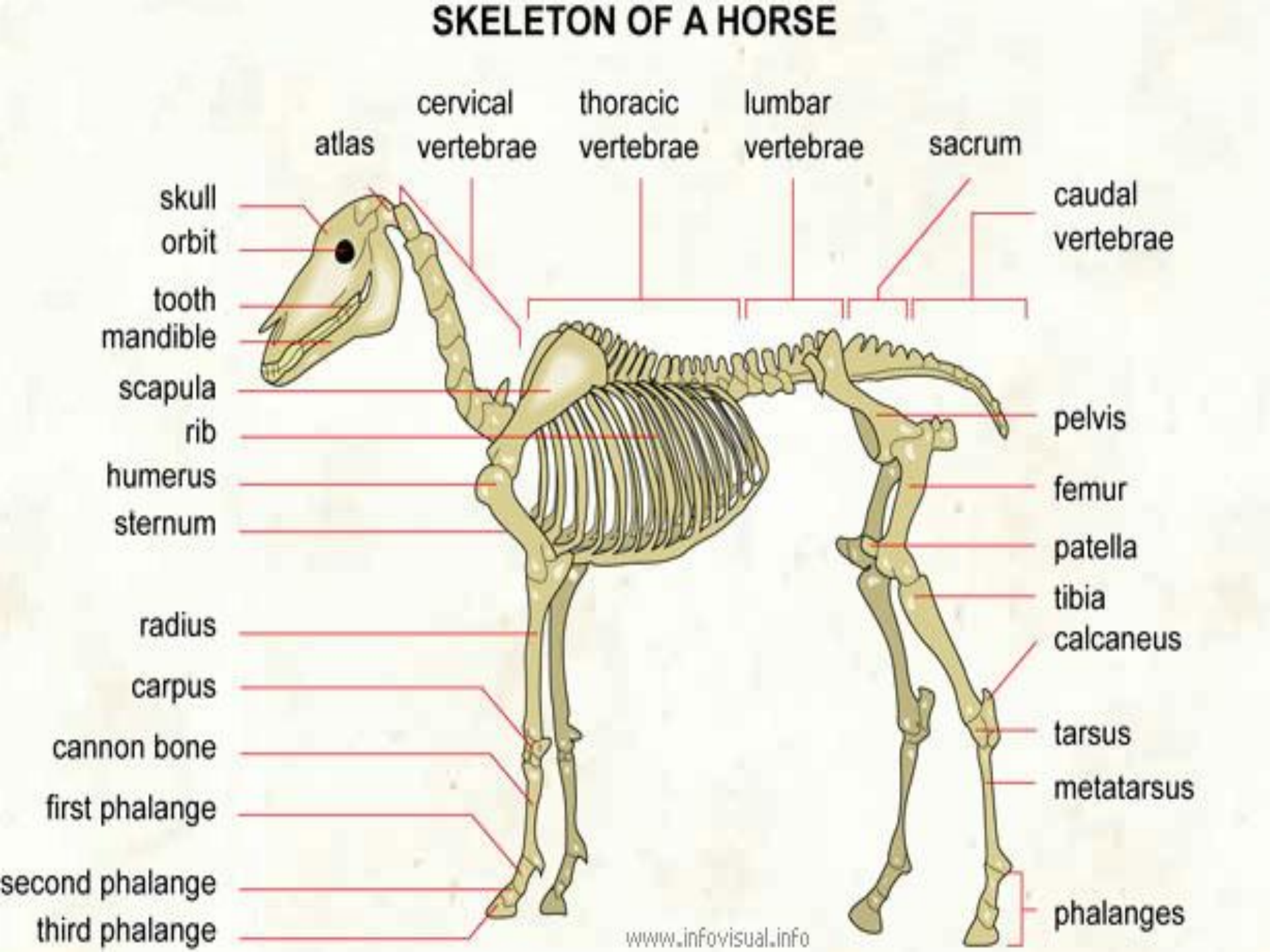
- **Fovea**:-small non articular/articular depression.
- **Foramen**:- a circumscribed hole in a bone. It is a perforation for the transmission of vessels, nerves.
- **Canal:-** a tunnel through one or more bone
- **Fissure**:- a long narrow slit or groove on the bone. e.g., palatine fissure



Regional classification of Bones

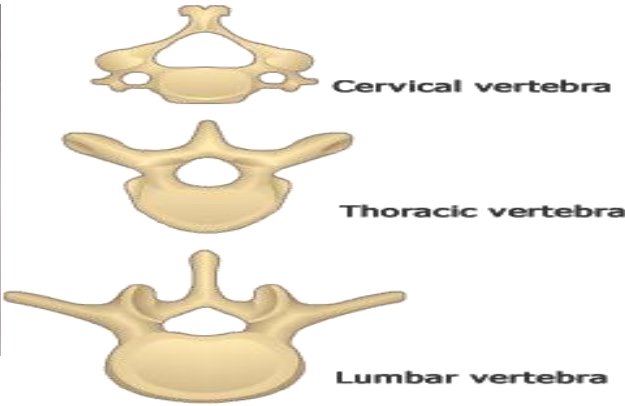
1. **Axial skeleton**
2. **Appendicular skeleton**
3. **Visceral (splanchic) skeleton**

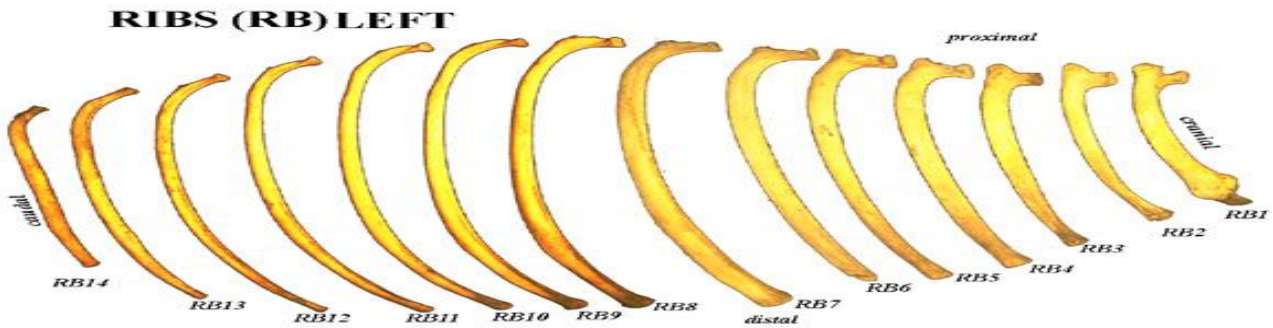
SKELETON OF A HORSE

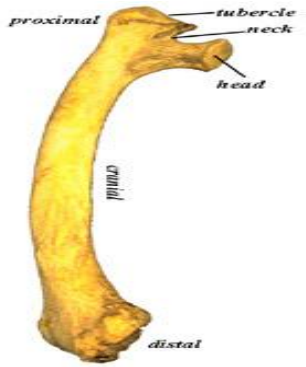


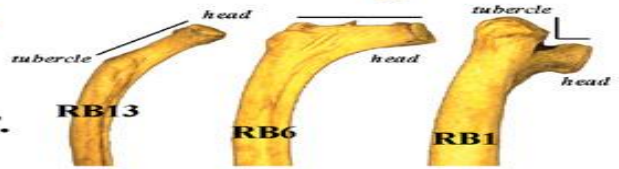
1. Axial skeleton

- These consists of all visible bones, except those of limbs.
- Are either on the mid line or are attached to the midline bones.
- Includes:
  - Skull
  - Vertebrae
  - Ribs and Sternum









Cont'd……Axial bones

Skull		Vertebrae	Ribs	Sternum
Cranial bones	**Facial bones**			
Ethmoid Frontal Interparietal Occipital Parietal Pterygoid Sphenoid Temporal Vomer	Incisive Lacrimal Mandible Maxilla Palatine Nasal Turbinates (conchae) Zygomatic Hyoid apparatus	Cervical Thoracic Lumbar Sacral Caudal	▪True (joined to sternum by cartilages) ▪False (not directly connected to sternum) ▪Floating (fixed only at vertebrae; last 1 or 2 pairs)	Sternebrae Manubrim Xiphoid process

2. Appendicular bones: consists of all bones of the limbs

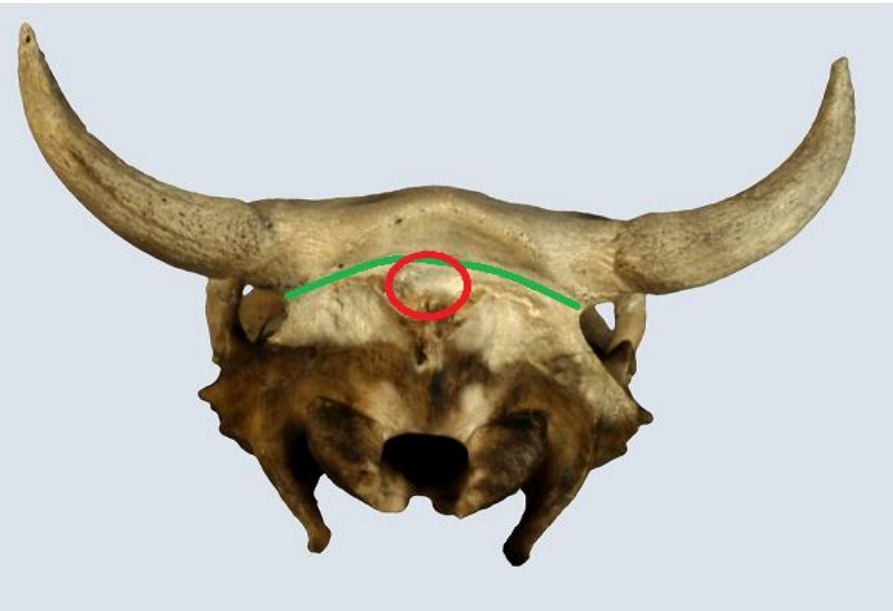
Fig. Limb bones

3. Visceral skeleton consists of those bone which grow in the soft tissue of the body

1. Axial skeleton

A. Skull:- the part of the skeleton within the head.

- It protects the brain, supports many of the sense organs, and forms passages for entry to the digestive and respiratory systems.
- The skull consists of the **cranial part** (braincase), which surrounds the brain, and the **facial part**.



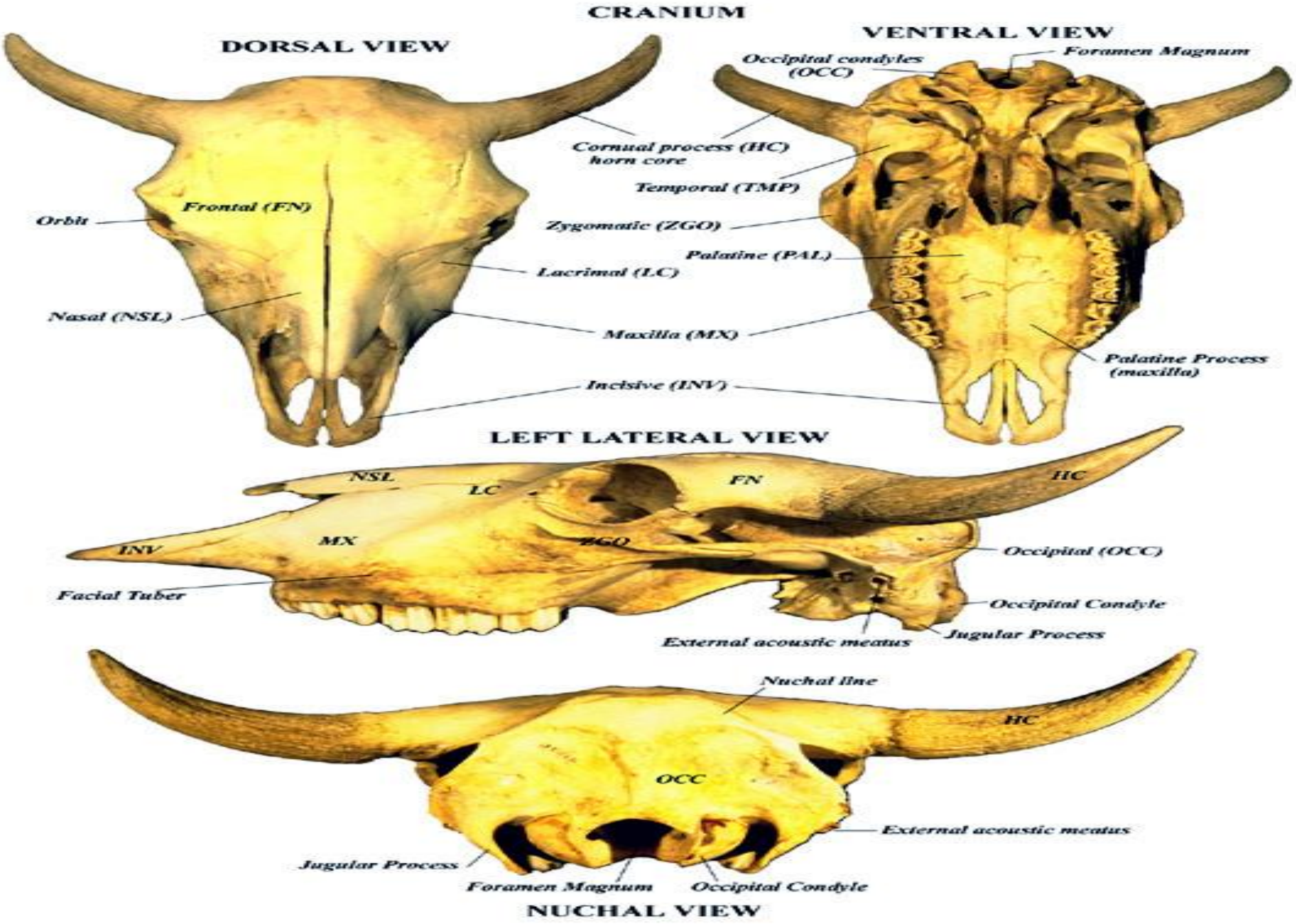
1. Cranial bones

The caudal and dorsal walls of the cranium are formed by:

- ✓Occipital,
- ✓Parietal,
- ✓Interparietal
- ✓Frontal bones
- ✓Cornual bones/process (in those possesses horns)

Laterally, ventrally and rostrally, the walls of cranium are formed by:

- ✓Temporal bones- laterally
- ✓Sphenoid bones- ventrally
- ✓Ethmoid bones- rostrally


CRANIUM
DORSAL VIEW
VENTRAL VIEW
Occipital condyles (OCC)
Foramen Magnum
Cornual process (HC) horn core
Temporal (TMP)
Frontal (FN)
Orbit
Zygomatic (ZGO)
Palatine (PAL)
Lacrimal (LC)
Nasal (NSL)
Maxilla (MX)
Palatine Process (maxilla)
Incisive (INV)
LEFT LATERAL VIEW
NSL
LC
FN
HC
INV
MX
ZGO
Occipital (OCC)
Facial Tuber
Occipital Condyle
External acoustic meatus
Jugular Process
Nuchal line
HC
OCC
External acoustic meatus
Jugular Process
Foramen Magnum
Occipital Condyle
NUCHAL VIEW

Occipital bone:- forms the caudal and basilar aspect (floor and vault) of the cranial cavity.

- Some features on this bone includes:
  - ✓*Foramen magnum*:- opening which transmit spinal chord.
  - ✓*Occipital condyle*:- portion which articulate with atlas (first cervical vertebra).
  - ✓*Jugular process*:- prominence for attachment of muscle.
  - ✓*Nuchal crest*:- the prominent ridge on the caudal aspect of the bone.

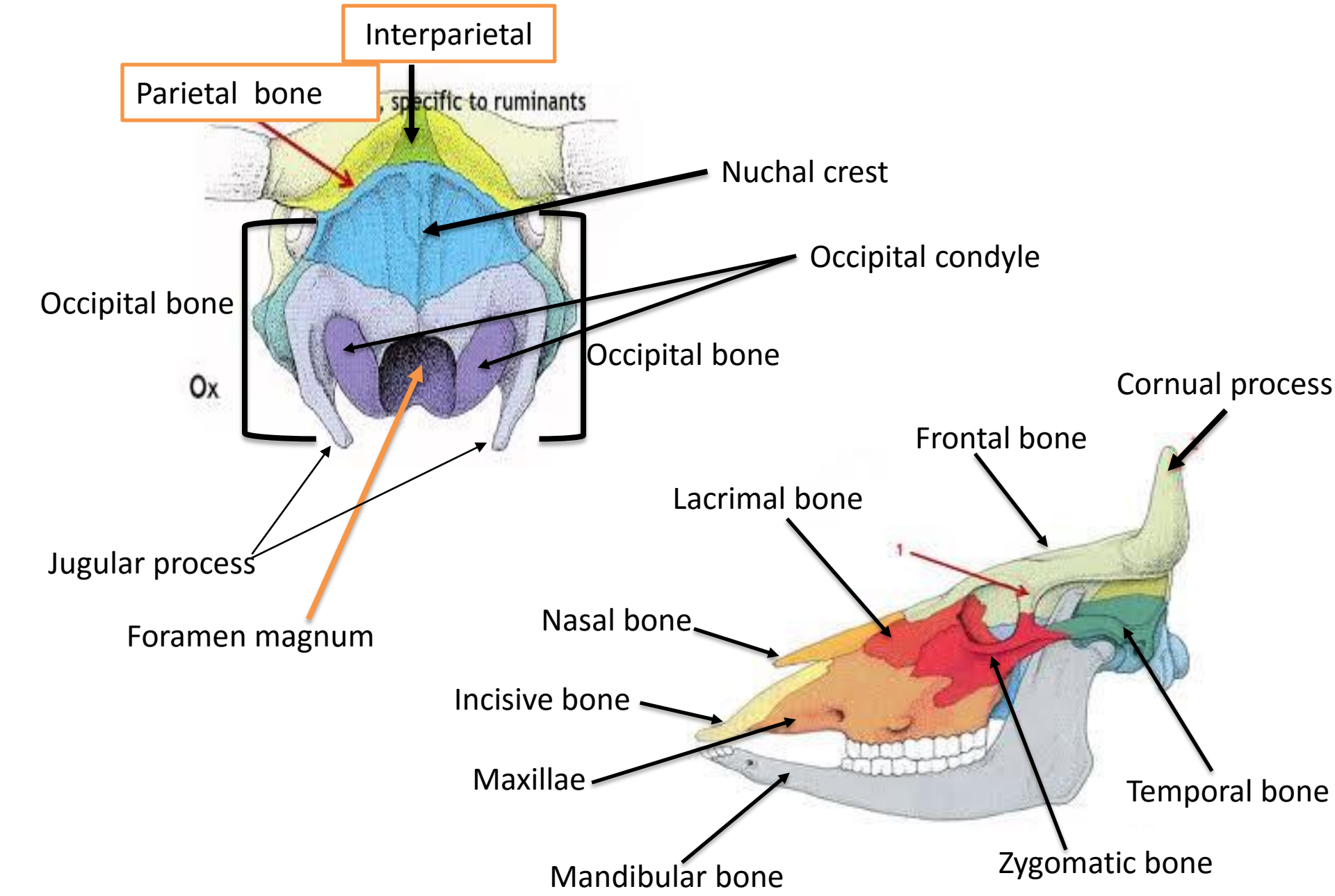
Interparietal bone:- a small bone rostral to the occipital bone found between parietal bone.

Sphenoid bone

- Basis sphenoid (body) + presphenoid (two wings).
- Forms the floor of the cranial cavity rostral to basilar portion of occipital bone.
- It supports brain and pituitary gland
- Separated from occipital bone by transvese elevation called **spheno-occipital crest.**

Temporal bone:- forms the greater lateral part of the cranial cavity

- ✓*Squamus part*:- the ventrolateral wall of the cranium
- ✓*Petrous part*:- a part consisting or forming the bony frame of the ear

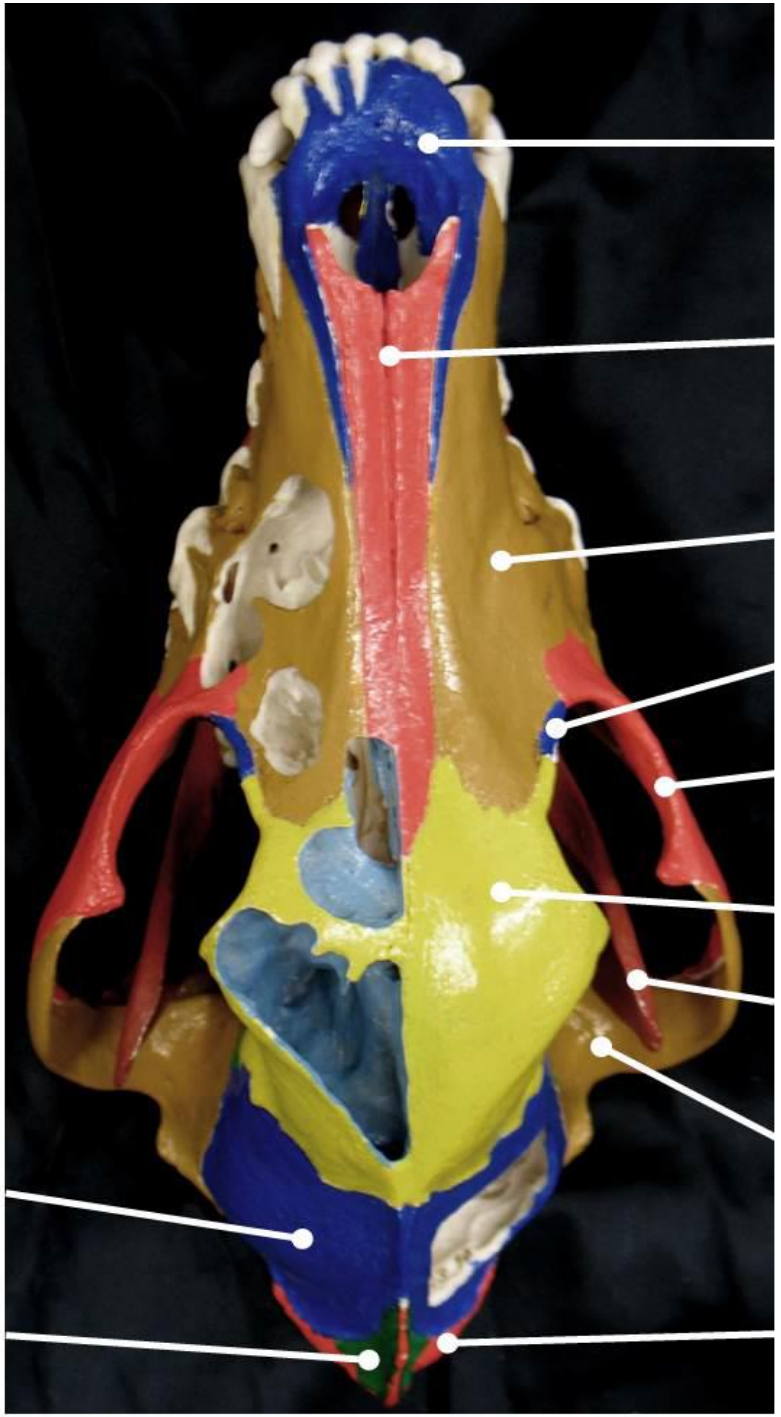

Interparietal
Parietal bone
specific to ruminants
Nuchal crest
Occipital condyle
Occipital bone
Occipital bone
Ox
Jugular process
Foramen magnum
Cornual process
Frontal bone
Lacrimal bone
Nasal bone
Incisive bone
Maxillae
Mandibular bone
Temporal bone
Zygomatic bone

Parietal bones:- form the roof of cranial cavity rostral to the occipital (squamous occipital) and

Frontal bones:- form the rostral roof of the cranial cavity and found between parietal and nasal bones

Ethmoid bone:- forms the rostral wall of the cranial cavity.

- ✓ A sieve like portion of this bone called **cribriform plate**


Incisive
Nasal
Maxilla
Lacrimal
Zygomatic
Frontal
Mandible
Temporal
Parietal
Inter-Parietal
(unpaired)
Occipital


Intermandibular joint
Vomer (unpaired)
Presphenoid (unpaired)
Pterygoid
Basisphenoid (unpaired)
Mandible
Maxilla
Palatine
Zygomatic
Frontal
Mandible
Temporal
Occipital

2. Facial bones

They forms bony frame of the face

Facial portion of skull consist of the following part

- ✓Maxillae
- ✓Incisive
- ✓Palatine Bones
- ✓Petrygoid bone
- ✓Nasal Bones
- ✓Lacrimal Bones
- ✓Zygomatic Bones
- ✓Nasal conchae (nasal turbinate)
- ✓Mandible
- ✓Hyoid
- ✓Vomer

Maxillae:- form the basal part of the upper jaw (contain the sockets of upper cheek and canine teeth).

- ✓Meet with some caudal bones (temporal & frontal) and almost all facial bones.
- ✓Each has zygomatic process, sinuses (maxillary sinuses) and infra orbital foramina.

Incisive bone(premaxillae):- form the rostral part of the upper jaw.

- ✓The two incisive bones meet rostro medially at premaxillary symphysis.
- ✓Rostrally on the line of union there is incisive foramen

Palatine bones:- the major osseous component of the hard palate which form the bony roof of oral cavity.

Pterygoid bones:- small flattened bones situated on either side of the caudal nares.

Nasal bones:- form the roof of nasal cavity.

Lacrymal bones:- found anterior to the orbit of the eye.

- ✓Has foramina (lacrimal foramina) through which the lacrimal duct pass from the orbit to the nasal cavity

Zygomatic (malar) bone:- are located ventral to the lacrimal

- ✓Has temporal process which meets with zygomatic process of squamous temporal bone (to form zygomatic arch) and frontal process which project to frontal bone.

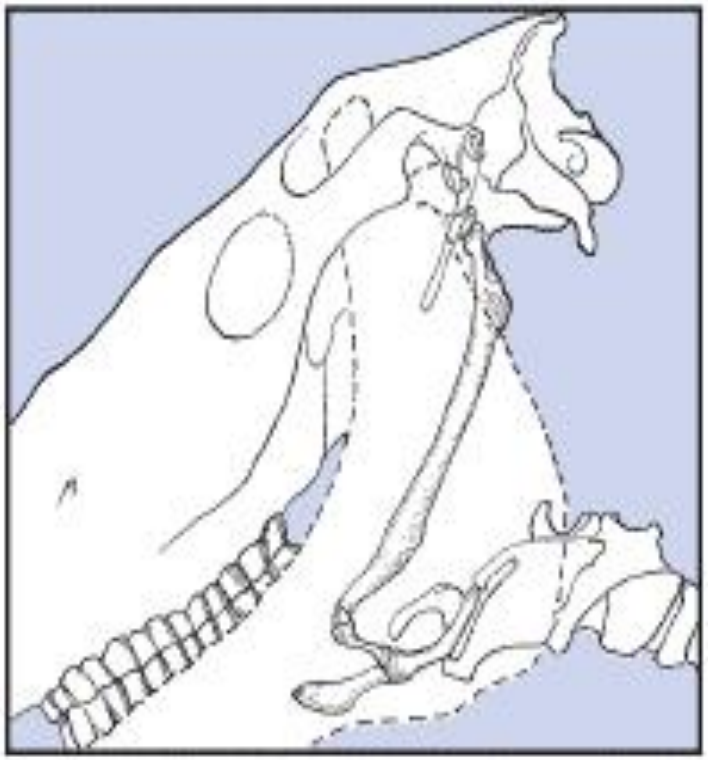
Nasal concha (turbinate):- very thin bone rolled into scroll-like formation and covered with mucous membrane

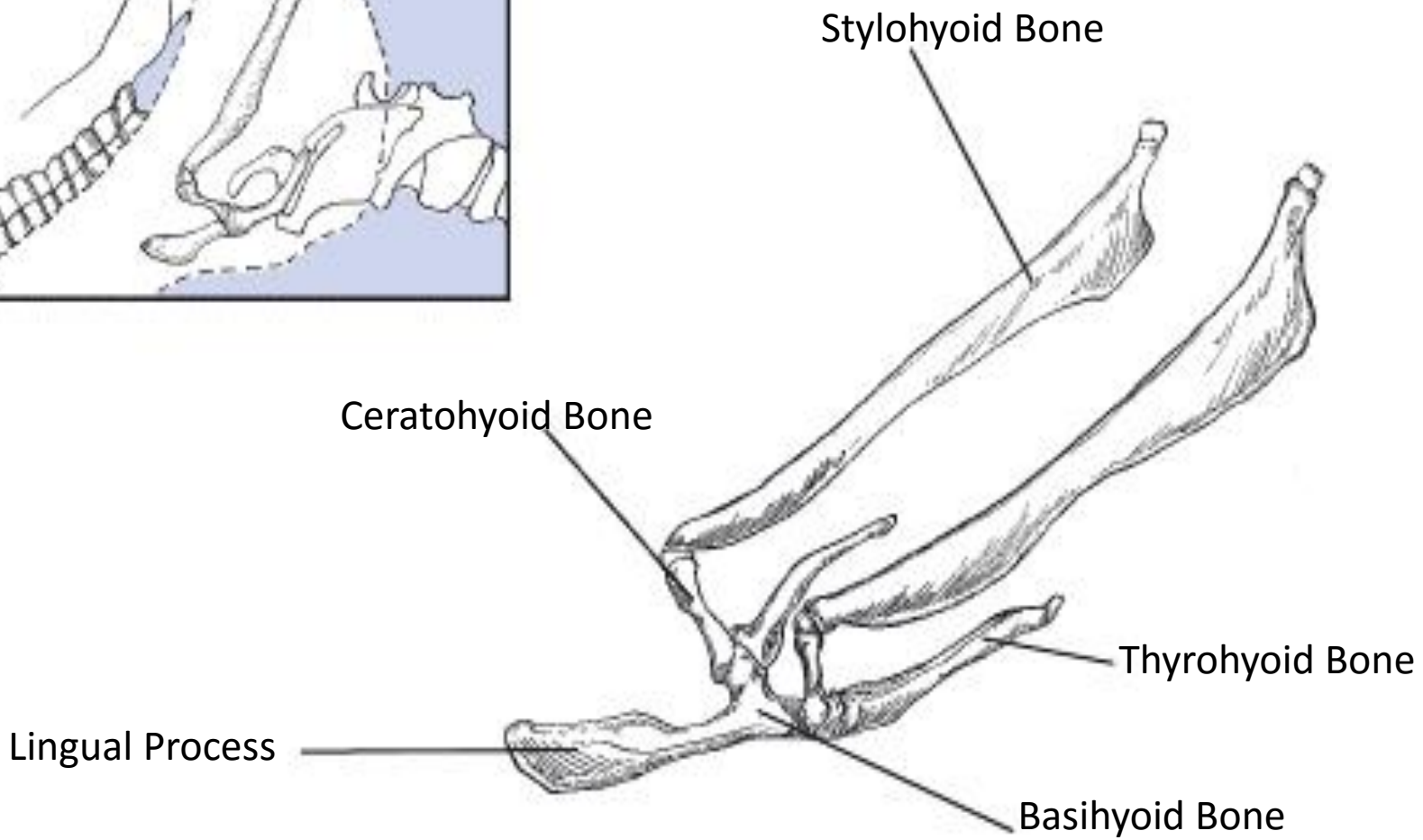
- ✓There are four turbinate arranged in two pairs (dorsal and ventral).

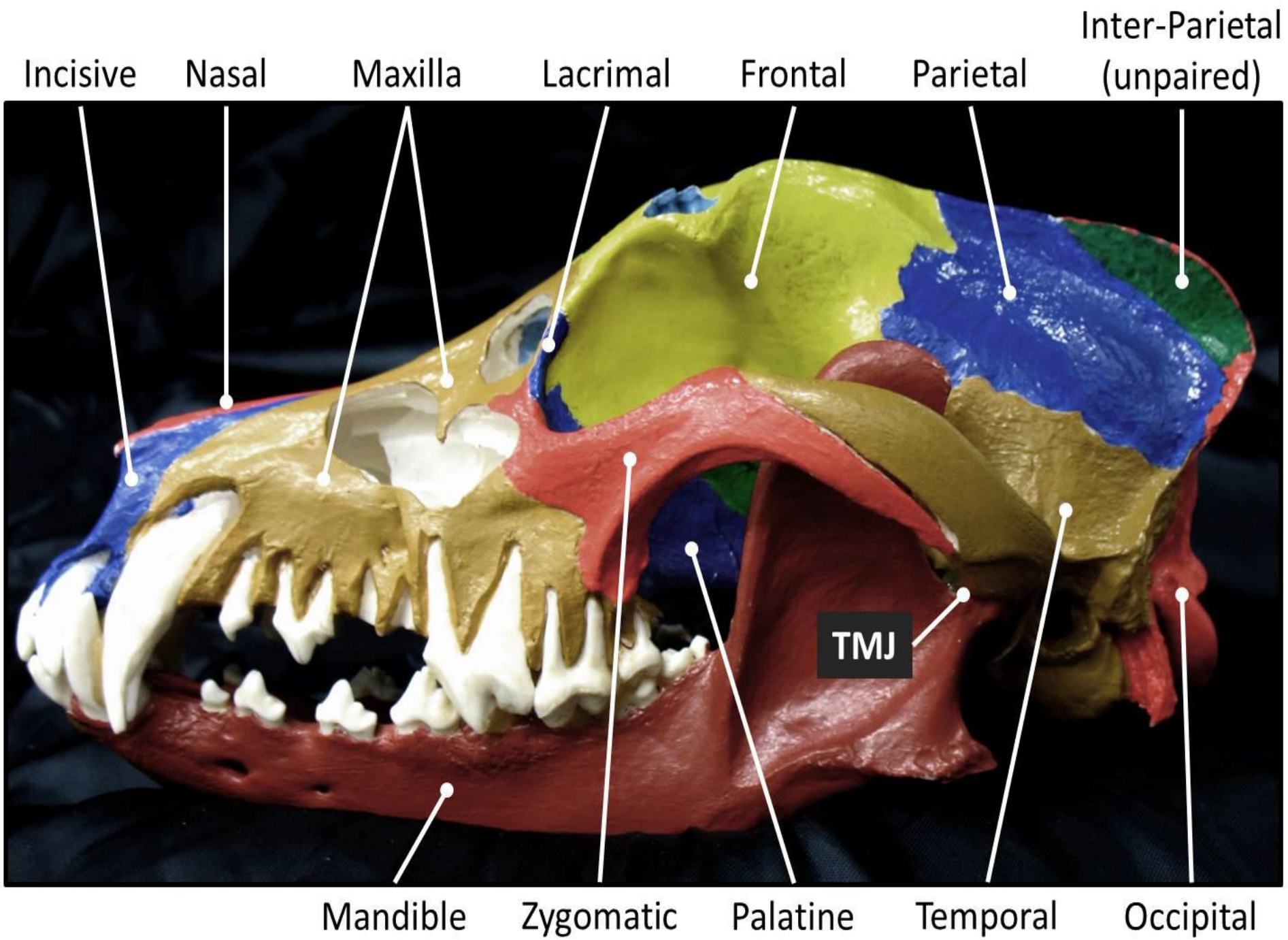
Mandible :- the largest bone of the face and forms the lower jaw; pair bone.

- ✓Consist of two portion: a *body* (horizontal portion) and *rami* (the vertical part).
- ✓There are mental foramina (laterally on the body) and mandibular foramina (medially about half up) on the rami.
- ✓Articulate with the squamous temporal bone by its condyloid process of the ramus.

- **Hyoid bone**:- consist of a series of bony rods joined together and suspending the tongue and larynx to the skull (temporal region).
- **Vomer bone**:- a medial bone which enters the formation of the ventral part of the nasal septum.

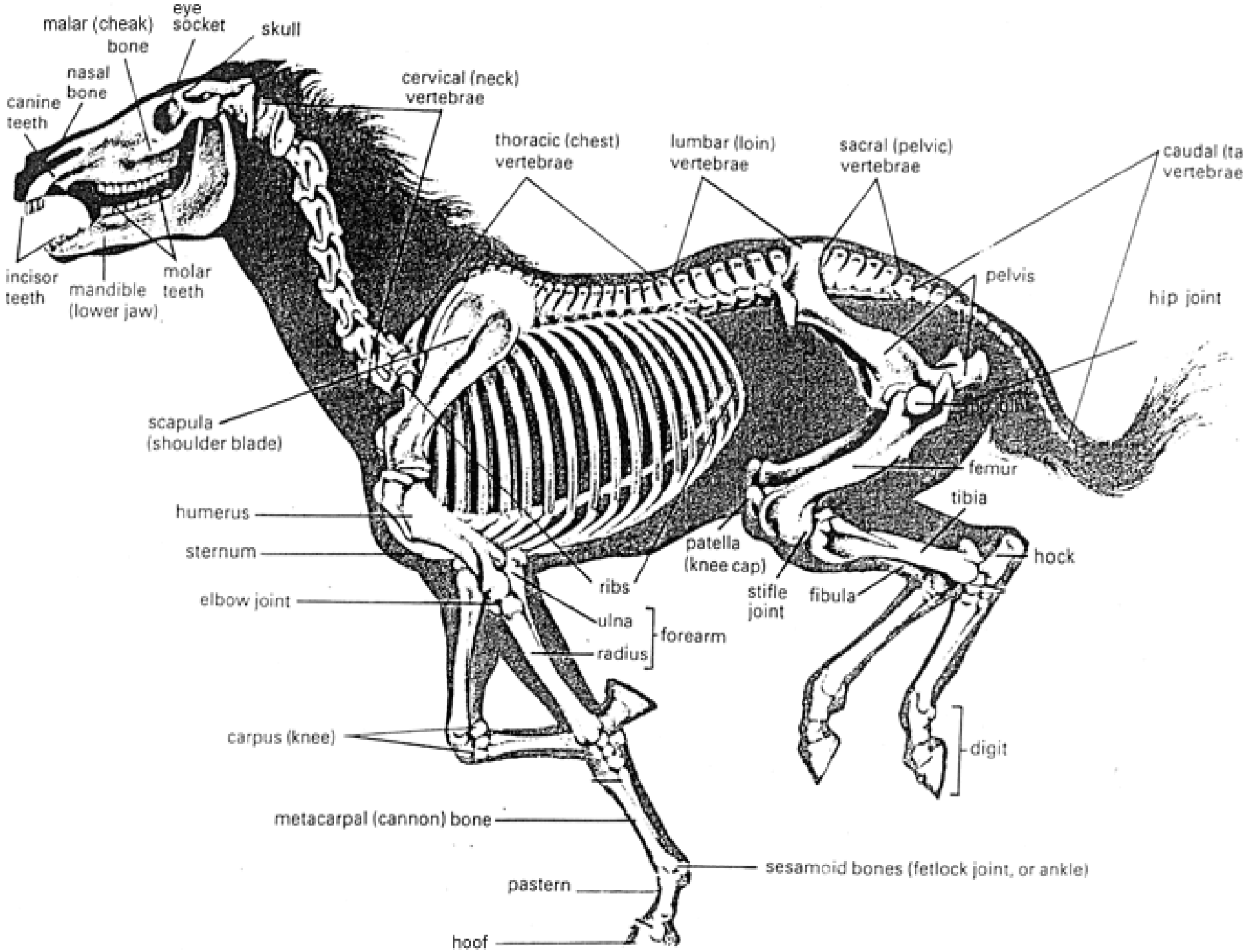



Stylohyoid Bone
Ceratohyoid Bone
Thyrohyoid Bone
Lingual Process
Basihyoid Bone


Incisive
Nasal
Maxilla
Lacrimal
Frontal
Parietal
Inter-Parietal
(unpaired)
TMJ
Mandible
Zygomatic
Palatine
Temporal
Occipital

B. Vertebrates

- Are median, unpaired, irregular bones forming the vertebral column.
- They extend from the skull to the end of the tail.
- The vertebral column divided into five regions which are named according to the part of the body in which they placed.
- These are:
  - ✓Cervical (C):- neck region
  - ✓Thoracic (T):- chest region
  - ✓Lumbar (L):- loin
  - ✓Sacral (S):- pelvic; they are fused together
  - ✓Caudal/coccygeal (cy):- tail


malar (cheak) bone
eye socket
skull
nasal bone
canine teeth
cervical (neck) vertebrae
thoracic (chest) vertebrae
lumbar (loin) vertebrae
sacral (pelvic) vertebrae
caudal (ta vertebrae
incisor teeth
mandible (lower jaw)
molar teeth
pelvis
hip joint
scapula (shoulder blade)
femur
humerus
tibia
sternum
patella (knee cap)
hock
ribs
stifle joint
fibula
elbow joint
ulna
forearm
radius
carpus (knee)
digit
metacarpal (cannon) bone
sesamoid bones (fetlock joint, or ankle)
pastern
hoof

- The number of vertebrae that compose these region vary among species, and to smaller extent individually.

Horse: $C_7T_{18}L_6S_5Cy_{15\text{-}21}$

Cow: $C_7T_{13}L_6S_5Cy_{18\text{-}20}$

Dog: $C_7T_{13}L_7S_3Cy_{20\text{-}23}$

Sheep: $C7T_{13}L_{6\text{-}7}S_4\ Cy_{16\text{-}18}$

Goat: $C_7T_{13}L_7S_4Cy_{12}$

Pigs: $C_7T_{14\text{-}15}L_{6\text{-}7}S_4Cy_{20\text{-}23}$

Chicken: $C_{14}T_7(L\&S)_{14}Cy_6$

Human: $C_7T_{12}L_5S_5Cy_4$

Camel: $C_7T_{12}L_7S_5Cy_{15\text{-}20}$

- A vertebral formula for a given species consists of the symbol for each region followed by the number of the vertebrae in that region.
- A typical vertebrae consists of the **body**, **arch** and **processes**
- **Body (Corpus)** is a cylinderical mass forming the ventral aspect of the vertebra and on which other parts are constructed.
  - The body connects with the bodies of adjacent vertebrae (by intervertebral fibrocartilagous disc).
  - Cranial surface of the body convex and its caudal surface is concave

- Ventrally rounded and dorsally flattened to form the floor of the vertebral canal.
- In thoracic region the body has two pairs of fovea on its cranial and caudal border (to articulate the head of two successive ribs).

❖ **Arch** is composed of two lateral halves and constructed dorsally to the body.

- The arches are notched cranially and caudally and the union of adjacent vertebral notches form **the inter vertebral foramina** (spinal nerve and vessels pass).

❖Processes

The articular processes: two cranial and two caudal project from the borders of the arch on either side.

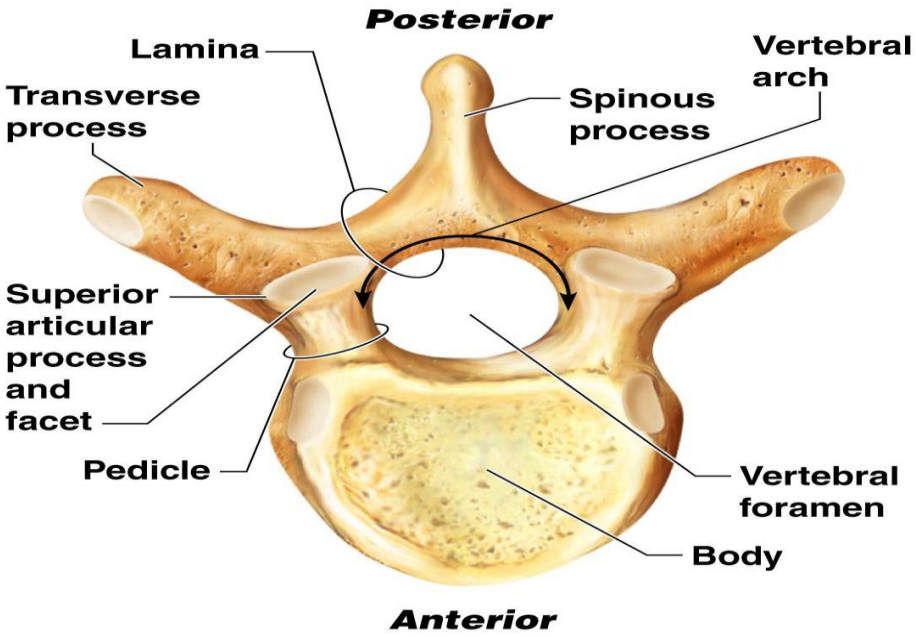
- They present joint surfaces adapted to those of adjacent vertebrate.

The spinous process: is single, and projects dorsally from the middle of the arch.

- It varies greatly in form, size, and direction in different vertebrate.
- It furnishes attachment to muscles and ligaments.

The transverse processes: are two in number and project laterally from the side of the arch.

- In the thoracic region each has a facet for articulation with the tubercle of a rib.
- They also give attachment to muscles and ligaments.



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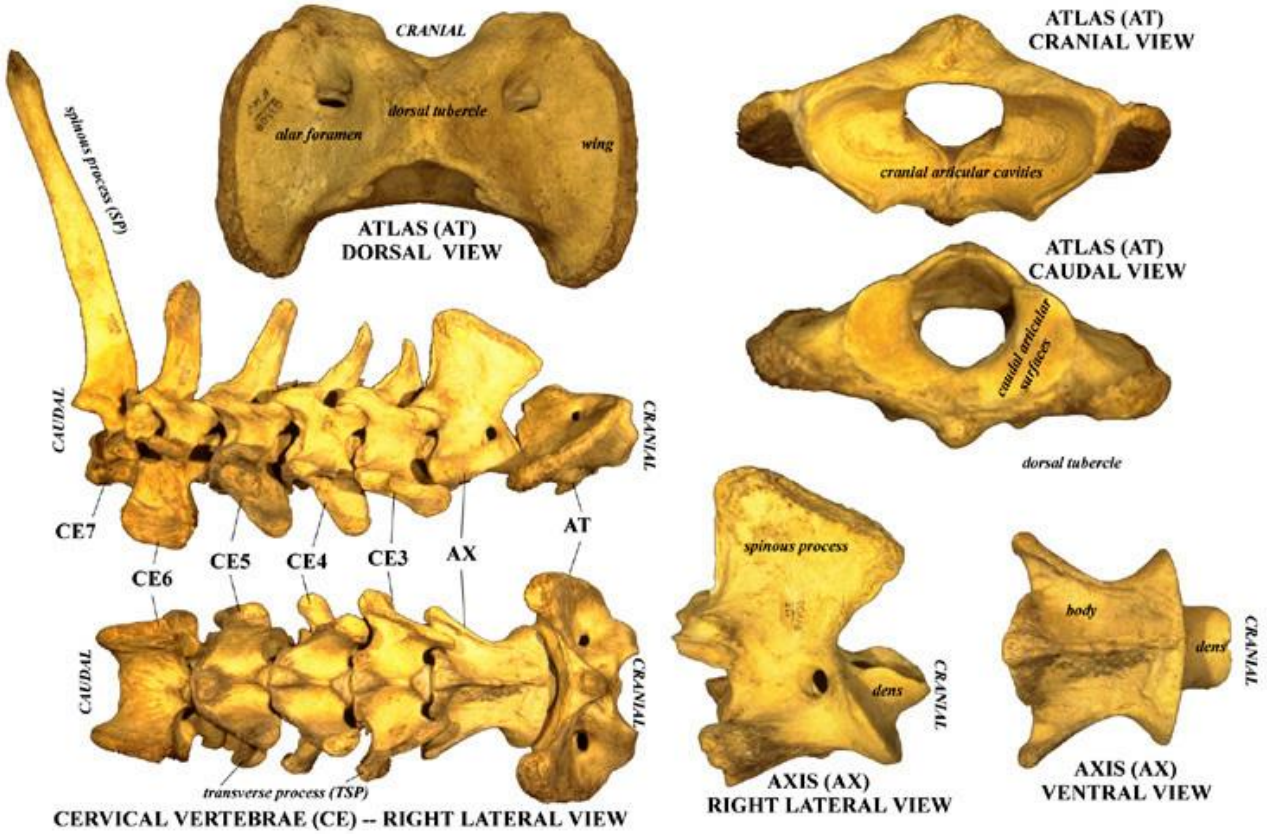
Mammillary processes: are found in most animals on the last thoracic and anterior lumbar vertebrae between the transverse and anterior articular processes or on the latter.

Accessory processes: when present, are situated between the transverse and posterior articular processes.

1. Cervical vertebrae

- These are quadrangular, massive, and longer than the vertebrae of other regions.
- They decrease in length from the second to the last.
- Bodies are rudimentary
- The arches are large and strong.
- The articular processes are large.
- The transverse processes are large and plate-like.
- The spinous process is represented by a crest and is rudimentary.
- From the 3^{rd} – 6^{th} cervical vertebrae the transverse process is perforated by a transverse foramen (nerves & vessels pass).



- Have well developed articular process.
- All domesticated mammals have seven cervical vertebrae.
- The first two the atlas and axis are more modified than the remaining five.

Atlas:

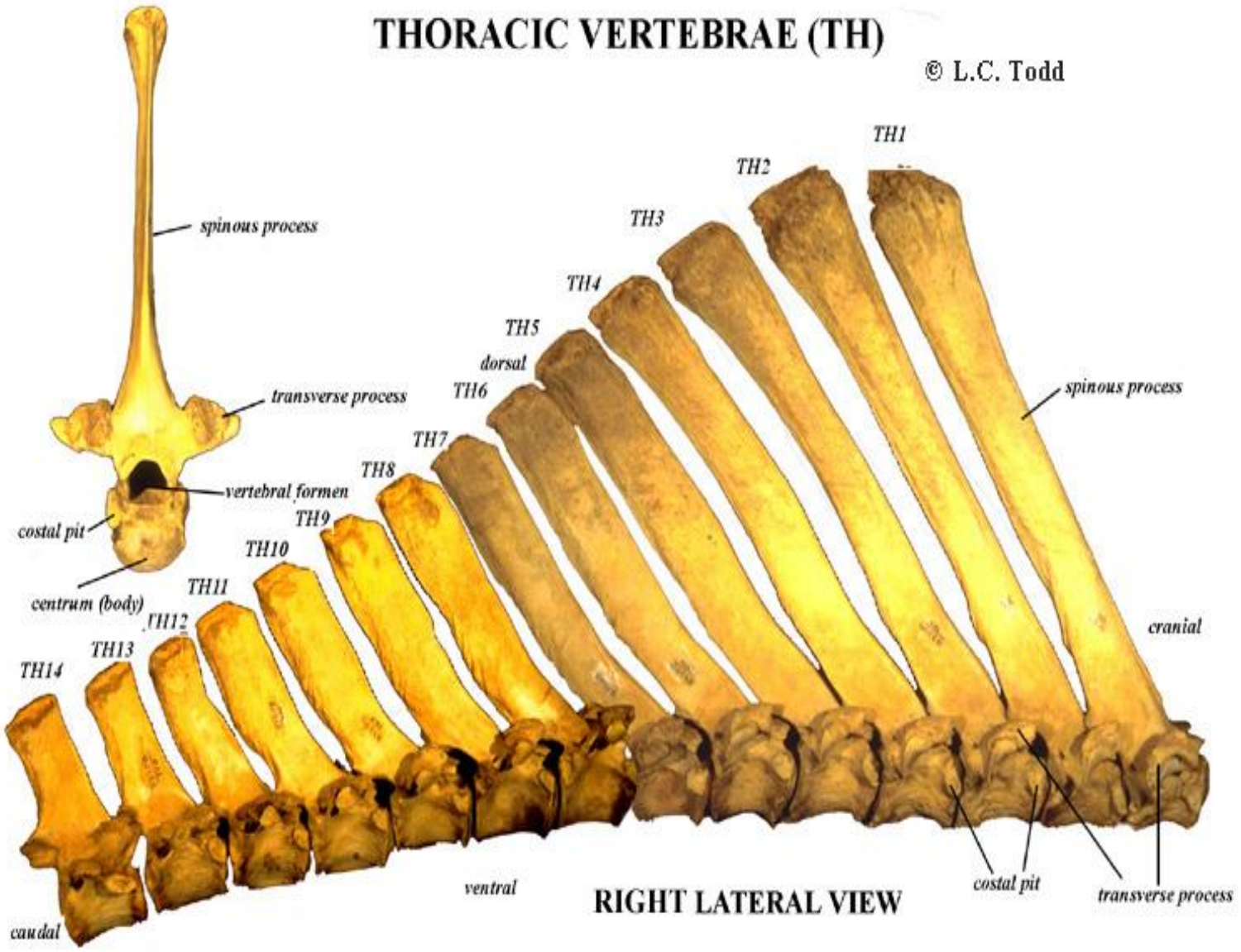
- First cervical vertebrae supporting the head.
- The body and spinous process are absent.
- Has a form of strong ring from which two wings (transverse process) project laterally.
- Has articular cavities which receive occipital condyle from cranial and caudal articular surface to articulate with axis.
- Dorsal face of ventral arch has caudally a transverse concave articular surface called *fovea dentis* on which the dense of the axis rests.
- Dorsal arch is perforated on either side near its cranial margin.

Axis:

- The second cervical vertebrae serving as a pivot around which the axis rotates.
- It is the longest of the vertebrae and characterised by the presence of **dens** (**odontoid process**).
- The caudal extremity of the body of axis has a cotyloid cavity.
- Has long and massive spinous process than atlas.

2. Thoracic Vertebrae

- Vary in number between species.
- Articulate with the respective number of the ribs.
- Have **short bodies** with flattened extremities.
- ***Costal fovea*** on the bodies of adjacent thoracic vertebrae form cavities for articulation with the heads of the ribs.
- Each transverse process also features a facet for articulation with the tubercle of the rib of the same number as the vertebra.
- Has very **prominent spinous processes** which are inclined caudally.
- Arches closely fitting and low articular processes.


THORACIC VERTEBRAE (TH)
© L.C. Todd
spinous process
transverse process
vertebral formen
costal pit
centrum (body)
TH1
TH2
TH3
TH4
TH5
TH6
TH7
TH8
TH9
TH10
TH11
TH12
TH13
TH14
dorsal
cranial
caudal
ventral
costal pit
transverse process
RIGHT LATERAL VIEW

3. Lumbar vertebrae

- Differ from the thoracic vertebrae in their greater length of the body.
- **Long flattened transverse processes** that project laterally.
- Shorter height and forward slop of the spinous processes.
- Better developed articular processes than thoracic, but lower than cervical.
- Prominent mammillary and accessory processes.

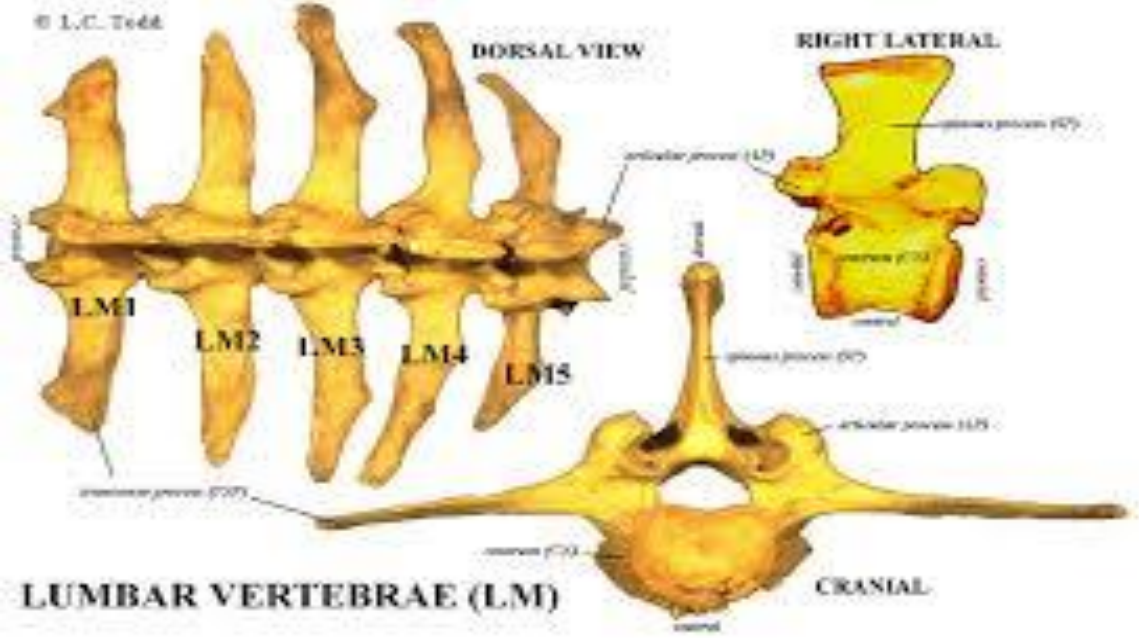
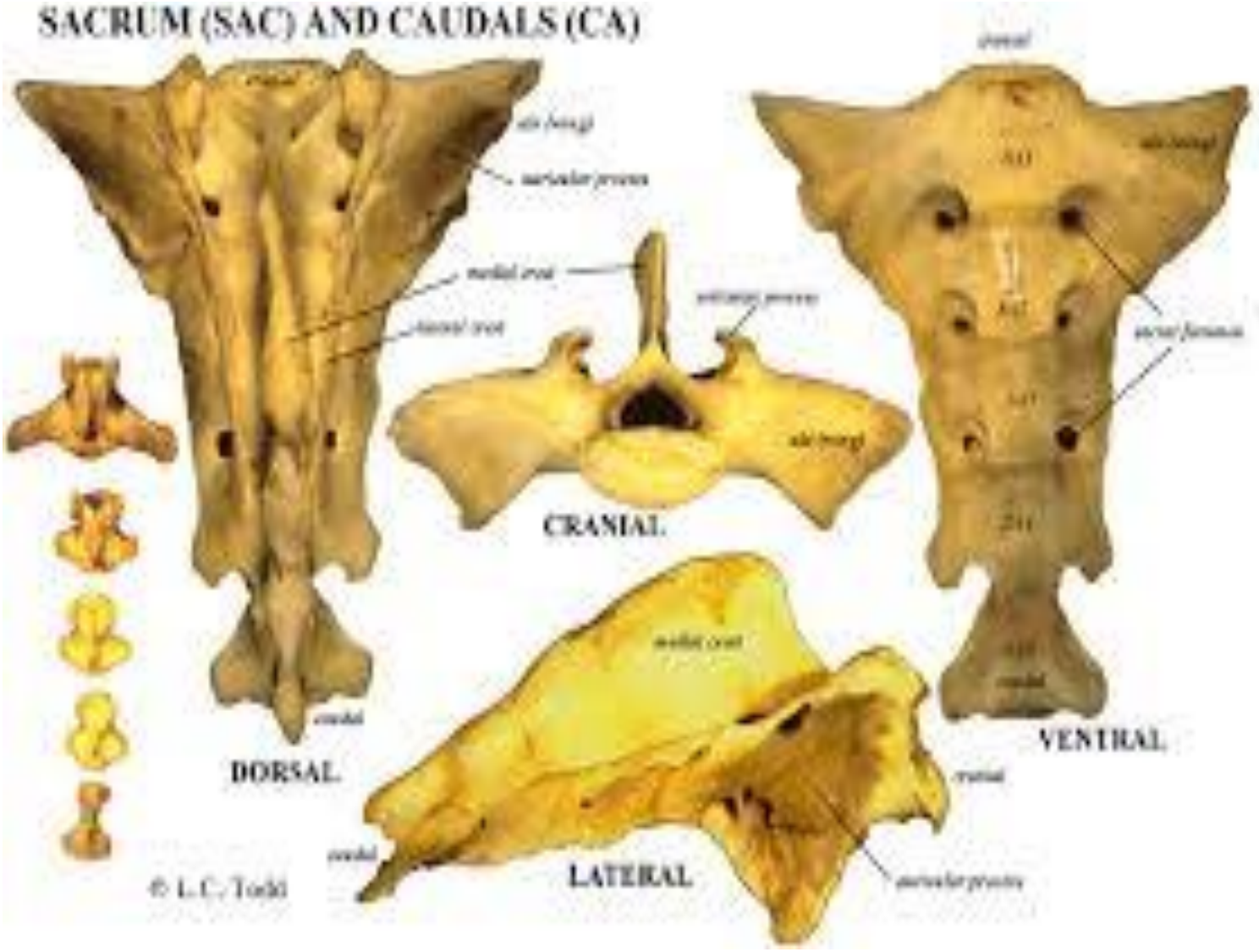


Figure of lumbar vertebrae

4. Sacral Vertebrae

- Are fused to form a single wedge shaped bone known as ***sacrum***.
- Sacrum articulate with lumbar vertebrae cranially and coccygeal vertebrae caudally and the wings of iliac bone craniolaterally.
- The dorsal surface of sacrum has spinous process (absent in the pig).
- In dog and horse the spine preserve their independence while in ruminant they are fused.
- The inter vertebral foramina of the sacrum are represented by dorsal and ventral rows of sacral foramina on dorsal and ventral sides of the sacrum.
- This foramina gives passages for spinal nerves.


SACRUM (SAC) AND CAUDALS (CA)
DORSAL
CRANIAL
VENTRAL
LATERAL
© L.C. Todd

5. Caudal vertebrae

- Form the bony basis for the tail.
- Size of the vertebrae decreases rapidly in a caudal direction.
- The last few caudal vertebrae are merely small rods of bone.
- Their number vary greatly even within species.
- The first few resemble miniature lumbar vertebrae.
- The middle and the later members of the series reduced to simple rods (only body present).
- The ventral surface of the caudal vertebrae has a median groove for the caudal artery.
- Hemal arches or paired ventral hemal processes protect the caudal artery.

C. Ribs and Sternum

Ribs

- Are flat, elongated, curved bone forming the skeleton of the thoracic wall.
- Are arranged serially in pairs which usually correspond in the number to the thoracic vertebrae.
- Each consist of rib proper (bony dorsally) and costal cartilage (cartilaginous ventral part)

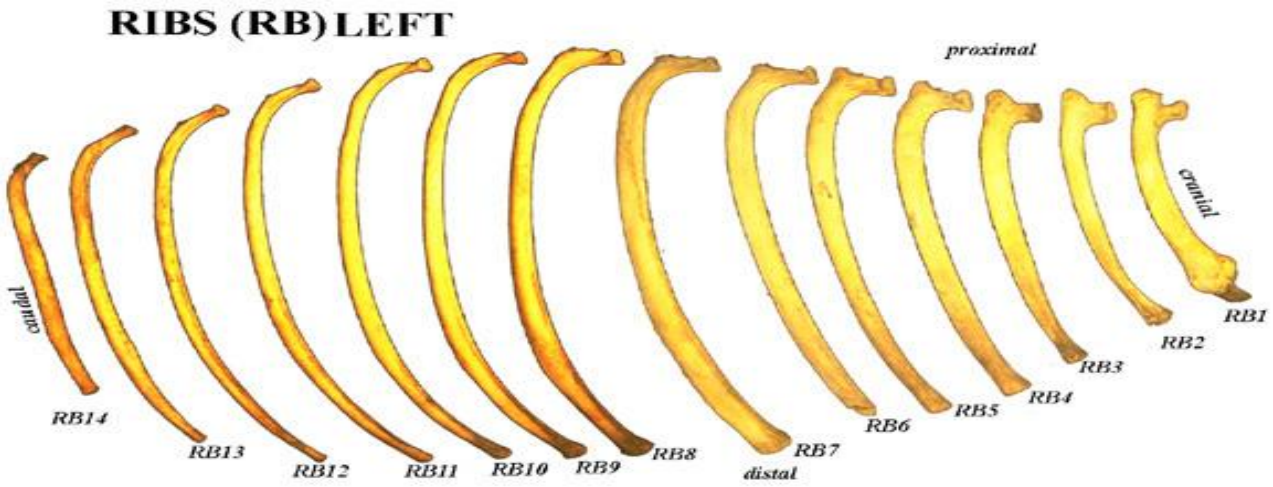
- Two portion of the rib meet at the costochondral junction
- The dorsal part of the rib articulate with two contiguous vertebrae and its cartilage articulate with the sternum.
- There are three types of ribs based on their articulation with sternum:
  - ✓ The rib that their cartilage articulate directly with the sternum are called *sternal ribs*.
  - ✓ Those ribs connected with sternum indirectly through overlapping are called *asternal ribs*.
  - ✓ At the end of the series ribs those which have ends free (not connected to the sternum) are called *floating ribs*

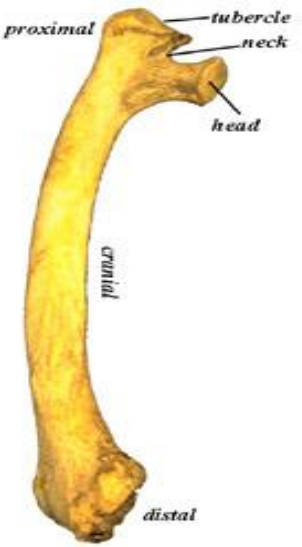
- The rib proper consists of a body and two extremities
- The body is a band-like and varies in length and breadth and curvature in different ribs & has lateral and medial surface.
- The vertebral extremity consists of the head, neck and tubercle.
- The head on the vertebral extremity articulates with the bodies of two adjacent thoracic vertebrae.

- The neck on the vertebral extremity joins the head with the body.
- The tubercle on the vertebral extremity projects caudally at the junction of the neck and the body.
- The tubercle has a fovea for articulation with the transverse process of the respective thoracic vertebrae
- The costal cartilages are bars of hyaline cartilage which serve to connect the rib directly or indirectly to the sternum.
- The cartilage of asternal ribs overlap to form the costal arch

Sternum

- Formed by a group of medial, ventral, segmental and unpaired bones.
- Sternum complete the thoracic skeleton ventrally.
- It gives attachment to the ***costal cartilages*** of the ribs as well as providing a bony origin for the pectoral muscles.
- The cranial extremity of the sternum is the **manubrium** and the caudal extremity is the **xiphoid process.**
- The individual bones between two extremity are called **sternebrae** that tend to fuse as age advances and varies in numbers with species.


RIBS (RB) LEFT
proximal
caudal
cranial
RB14
RB13
RB12
RB11
RB10
RB9
RB8
RB7
RB6
RB5
RB4
RB3
RB2
RB1
distal


proximal
tubercle
neck
head
cranial
distal


STERNAL BODIES (SN)
manubrium (MN)
xiphoid (ZY)
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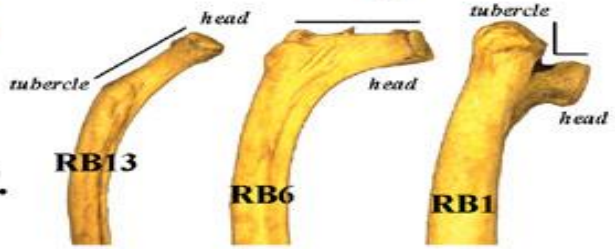
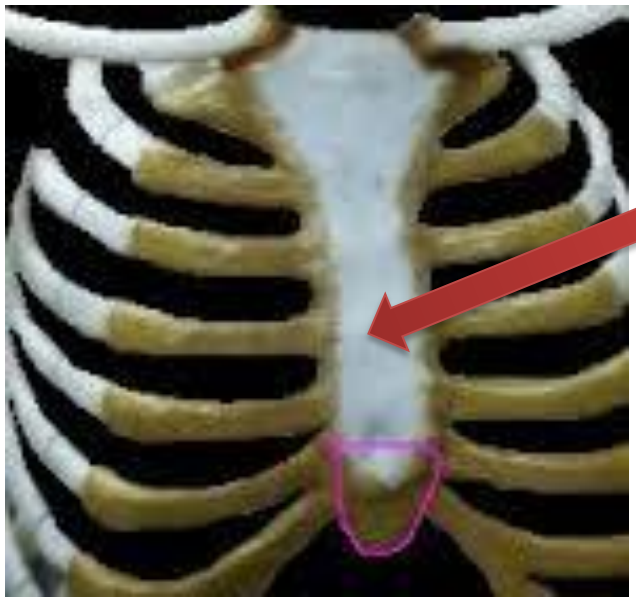
COSTAL CART.
(CS)


head
tubercle
RB13
head
RB6
tubercle
head
RB1



Sternum

2. Appendicular skeleton

- Is made up of the bones of the front (pectoral) and hind (pelvic) limb.

Pectoral (thoracic) limb

- ✓ Shoulder girdle
  - ✓ Scapula
  - ✓ Clavicle
  - ✓ Coracoid
- ✓ Humerus
- ✓ Radius & Ulna
- ✓ Carpal bones
- ✓ Metacarpal bones
- ✓ Digits

Pelvic limb

- ✓ Pelvic girdle
  - ✓Ilium
  - ✓Ischium
  - ✓pubis
- ✓ Femur
- ✓ Patella
- ✓ Tibia & Fibula
- ✓ Tarsal bones
- ✓ Metatarsal bones
- ✓ Digits

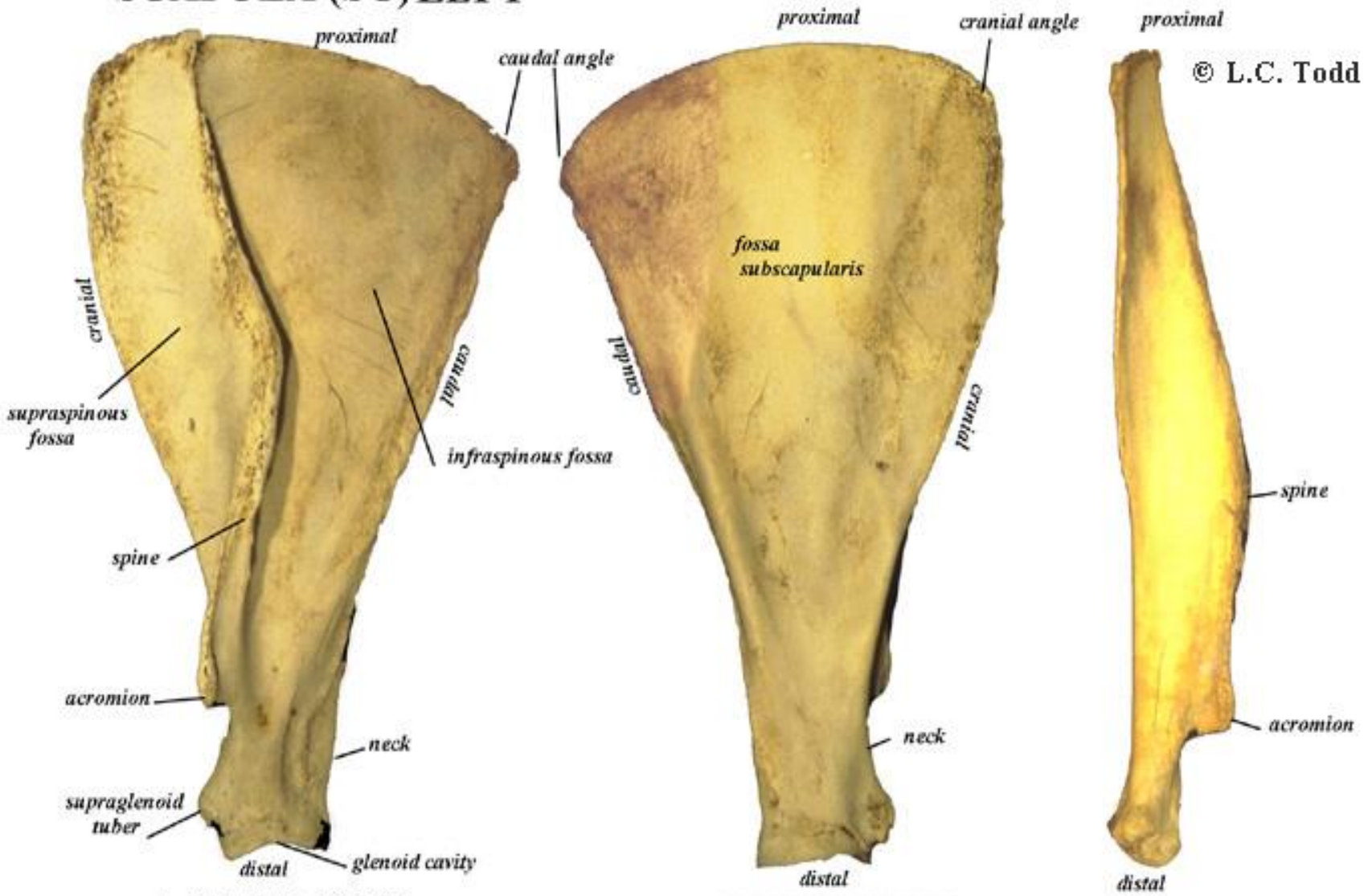
A. Bones of Pectoral limb

1. Shoulder girdle

a. Scapula

- ✓ Flat triangular bone.
- ✓ Has two surface (lateral and costal(medial)).
- ✓ Three angle (cranial, caudal and ventral angle).
- ✓ The ventral angle articulate with the humerus.
- ✓ Has three border cranial, caudal and dorsal border.
- ✓ The lateral face has a spine dividing this face into *supra* and *infra spinous* fossa.

SCAPULA (SC) LEFT



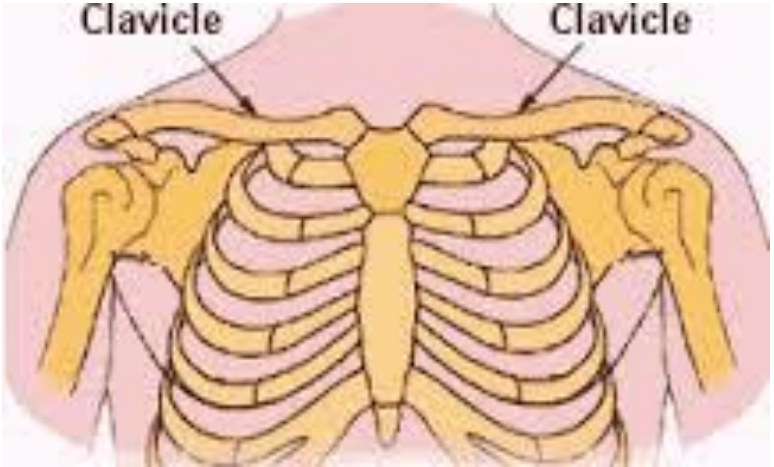
- In carnivores, ruminants and camels, the distal end of the spine is flattened to form the ***acromion process.***
- The costal (medial or deep) face has depression called scapular fossa.
  - ✓ It gives attachment to some of the muscles that connect the limb to the body.

b. Coracoid bone

- ✓ In humans and domestic mammals it has been reduced to the **coracoid process (a bony prominence).**
- ✓ Birds posses a well developed coracoid bone.

c. Clavicle (collar bone)

- It forms a joint with scapula.
- Birds and man have clavicle and cats has vestigial clavicle.
- But in most quadruped animals, the clavicle is represented only by the clavicular tendon.
- The fused clavicles are called the **furcula, or wishbone** in birds**.**



2. Humerus (arm bone)

- Is a long bone that varies in shape only in minor details from one animal to another.
- It has a shaft and two extremities.
- Shaft is irregular cylinderical and has a twisted appearance.
- The lateral surface is spirally curved forming a **musculospiral groove**.
- The proximal extremity consists of the head, neck & greater and lesser tuberosities and an inter tuberal groove

- The head articulate with glenoid cavity of the scapula to form the **scapulohumeral (shoulder)** joint.
- Crest of humerus bears deltoid tuberosity proximal to its middle part
- Proximal to *deltoid tuberosity* there is *teres minor tuberosity*
- The palpable prominence produced by this end of the humerus is called the *point of the shoulder.*
- The distal end of the humerus forms a spool like *condyle* that articulates with the proximal ends of the radius and ulna in the elbow.

- The distal extremity consists medial and lateral epicondyle and condoyle, the olecranon and radial fossa.

3. Radius and Ulna

Radius

- Radius is the longest of the two forearm bone.
- It is larger than ulna in mammals, but conversed in bird.
- Radius located on the medial side of the forearm; felt directly beneath the skin.
- Radius consists of two extremity and a body and at its junction with ulna it forms an *interosseous space*.
- The (condyle) distal extremity presents the carpal articular surfaces.

Ulna

- ✓ Varies in its degree of development between species.
- ✓ The proximal extremity called olecranon (form point of elbow).
- ✓ The cranial border of the olecranon bears a process called *anconeal process* which overhang the trochlear notch.
- ✓ The trochlear notch articulate with humerus.
- ✓ The proximal portion of the shaft of ulna is well developed in horses but fused to the radius.
- ✓ Cow, sheep, goat and pig have a complete ulna fused to the radius (but with restricted movement).
- ✓ In equine only proximal part of ulna is visible.
- ✓ In camel proximal and distal is found to radius, the most shaft part fused and not visible.
- ✓ Cats and dog have separate and complete fore arm bone with considerable movement.

4.Carpal bone

- Are short bones.
- Typically are eight in number.
- Arranged in two rows (proximal and distal row).
- Bones of the proximal row named from radial to ulnar as *radial*, *intermediate*, *ulnar*, and *accessory* carpal bones
- The bones of the distal row are designated numerically as the same direction (first, second, third and fourth).
- The numbering of the carpal bones of the distal row is based on an ancestral four.

- Among common domestic farm animals only the pig consistently has four carpal bones in this distal row.
- Carnivore have fused radial and intermediate (intermedio-radial carpal) and therefore has 7 carpal bone.
- In ruminant first is absent, 2^{nd} and 3^{rd} are fused and have six carpal bone.
- Horse may have 7 or 8 carpal bone (the first may or may not present).

5.Metacarpal bones

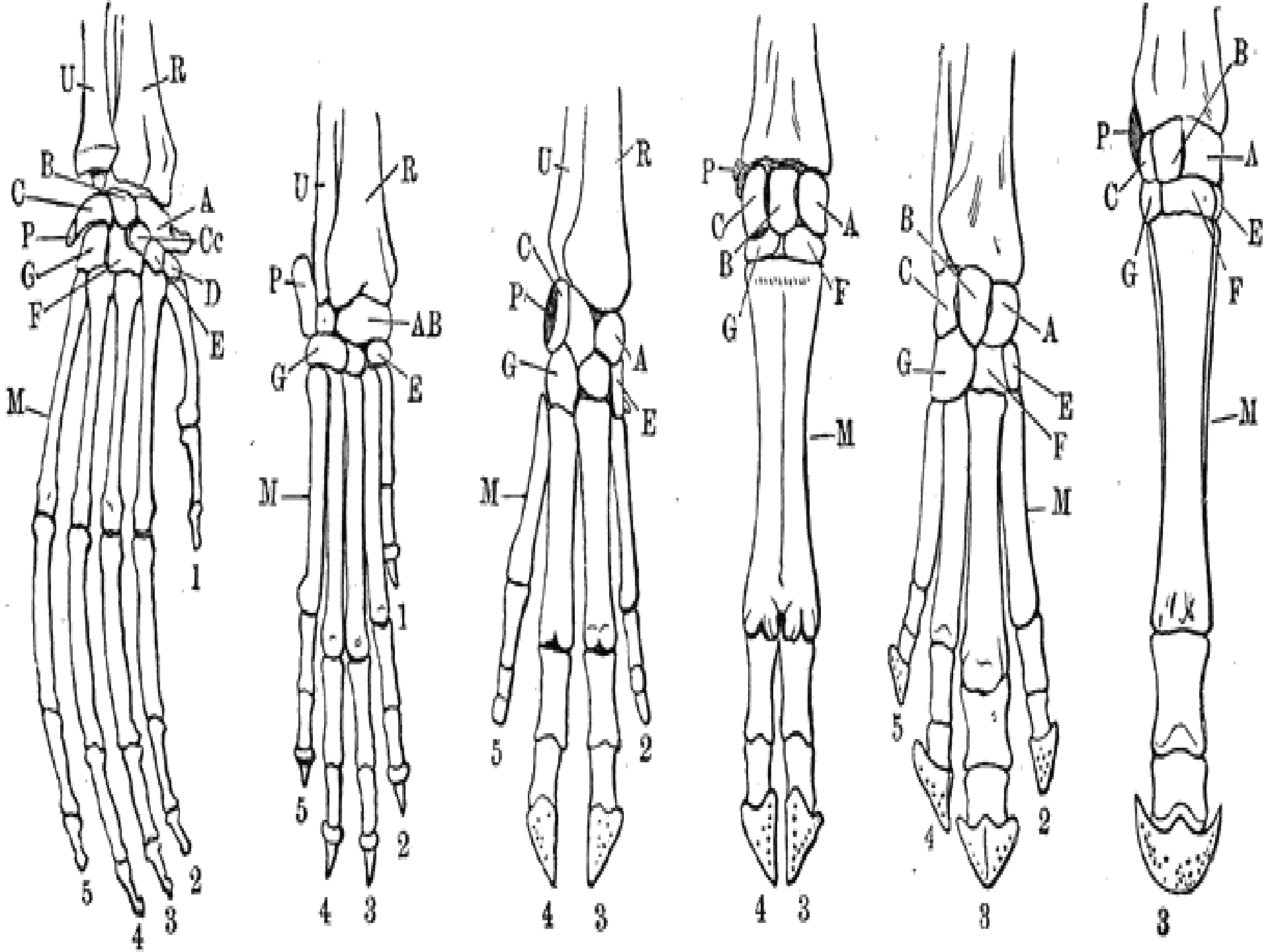
- Are long bones is immediately distal to the carpus.
- Typically are five in number (I-V) corresponding to each digit.
- Presents articular surfaces for carpal and digital bones proximally and distally respectively.
- Designated numerically from radial to ulnar side often abbreviated (MC1, MC2 etc).
- In ruminant 1^{st} & 2^{nd} are absent the 3^{rd} & 4^{th} are fused (cannon bone) which support the 3^{rd} and 4^{th} digits & the 5^{th} metacarpal bone is markedly reduced.

- In the horse the 1st and 5th are absent and the 2nd and 4th are reduced to form the splint bone.
- In the horse only the 3rd metacarpal bone support the 3rd digit.

- The pig has four metacarpal bones. The first is absent; the second and fifth are reduced in size; and the third and fourth bear most of the weight.
- In the dog and cat all five metacarpal bones are present.

6. Bones of the digit

- Are typically five in number and designated numerically from (radial to ulnar).
- Man and dog posses the full number of digits.
- Generally each digit possess three **phalanges** or segments (proximal, middle and distal) and two proximal and one distal sesamoid bone.
- Each digit articulate proximally with a metacarpal or a metatarsal bone and ends distally with a horny claw, nail or hoof.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- *Bovines*, *caprine* & *ovines* posses false digit or dewclaw (don't articulate with metacarpal or metatarsal bone).
- Horse has one digit per foot, ruminant has two, pigs have four, carnivore have five digit on the front and four or five on the rear foot & feline have five on the front and four on the rear foot.
- **Sesamoid bone** are bones which are located between phalanxes.
- Number of sesamoid bone varies in number between species.
- The horse posses two proximal and one distal sesamoid bone.

- Ruminant have six sesamoid bone per foot (two proximal and one distal).
- Swine has ten sesamoid bone per foot (three for each main digit (3 & 4) and two for each accessory digits (2 & 5).
- Dogs poses a maximum of 13 sesamoid bone per foot (4 dorsal & nine palmar (plantar).

Bones of Pelvic Limb

Pelvic limb

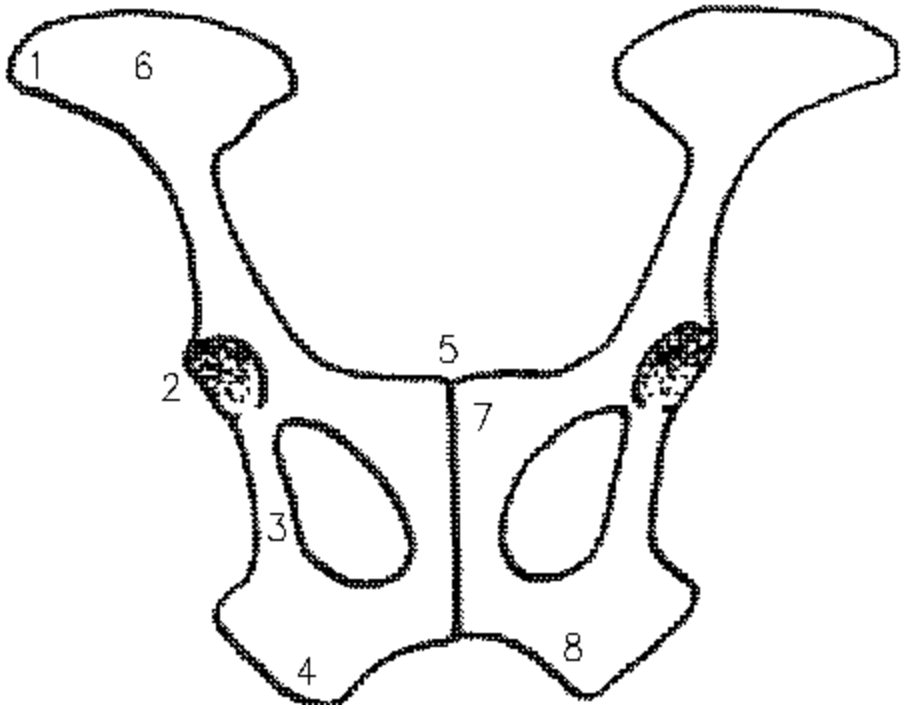
- ✓Pelvic girdle (pelvis)
  - ✓Ilium
  - ✓Ischium
  - ✓pubis
- ✓Femur
- ✓Patella
- ✓Tibia & Fibula
- ✓Tarsal bones
- ✓Metatarsal bones
- ✓Digits

1. Pelvic girdle

- The pelvic girdle, or bony pelvis, consists of the two hip bones (*ossa coxarum*), sacrum, and the first few caudal vertebrae.
- It encases the pelvic cavity
- Each ***hemi pelvis*** (*ossa coxarum*) comprises three bones, which are fused to form the ***os coxae, or*** **pelvic bone**.
  - Ilium
  - Ischium
  - Pubes
- These two *ossa coxarum* are firmly attached to one another at the **pelvic symphysis** ventrally and are joined to the sacrum of the axial skeleton by two strong **sacroiliac joints**.

A. Ilium

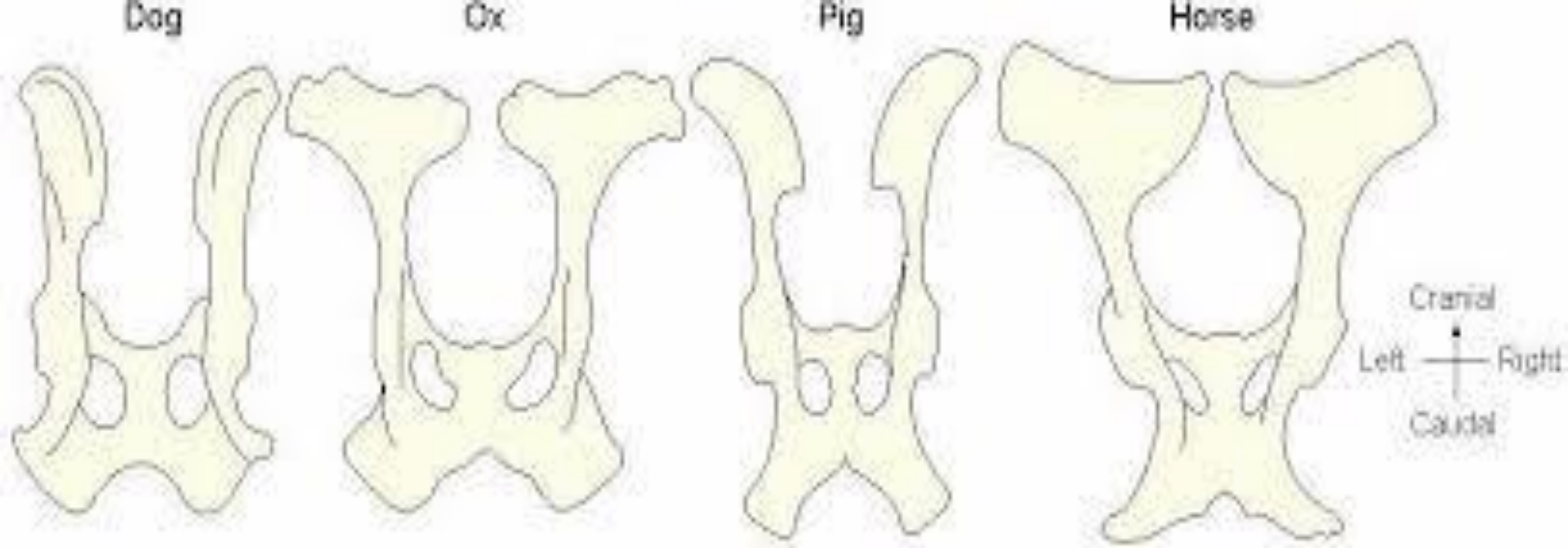
- The ilium is the largest and most cranial of the *os coxae*, consisting of a wing and body.
- It is irregularly triangular, with the apex at the *acetabulum* and the base projecting craniodorsal.
- It forms the cranial part of the *acetabulum* and its wings articulates with the sacrum at the ***sacroiliac joint***.
- The medial angle, the ***tuber sacrale,*** is close to the *sacroiliac joint* near the midline. The lateral angle, the ***tuber coxae***, is known as the *point of the hip*.

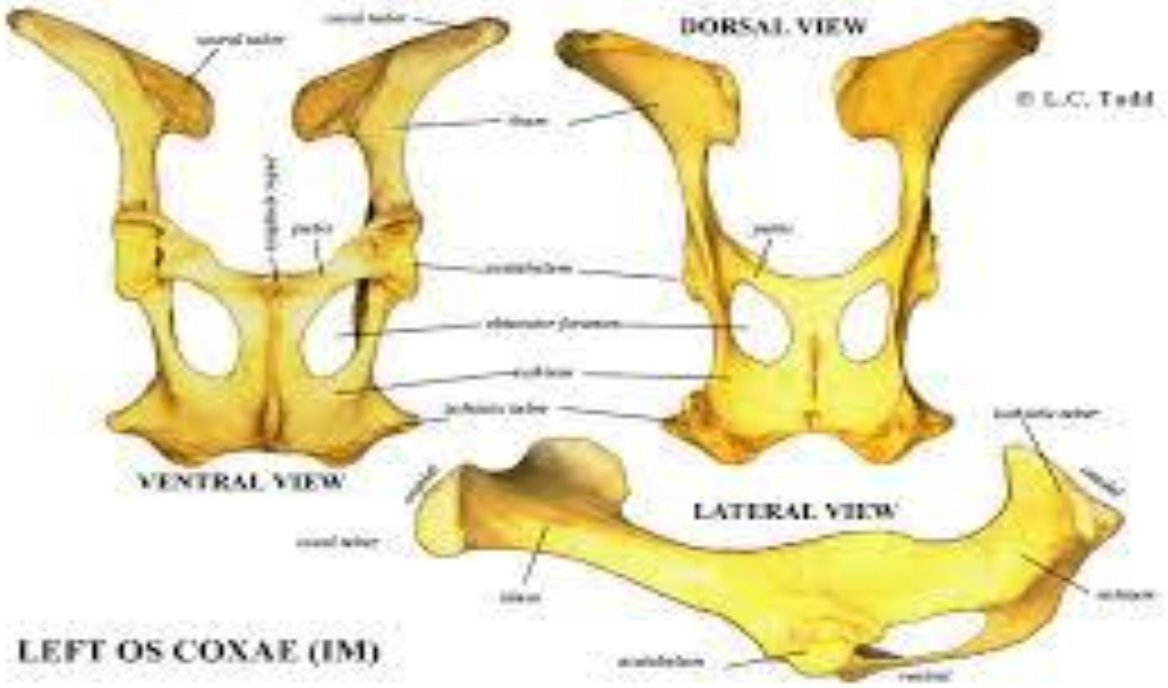


- The broad, flat portion between the tuber coxae and tuber sacrale is the *wing of the ilium***,** and the dorsal margin is the *iliac crest***.**
- The body of the ilium projects ventral and caudal between the wing and acetabulum and helps form the lateral wall of the pelvic cavity.

B. Ischium

- The ischium projects backward and ventral from the *acetabulum*, forming much of the floor of the pelvic cavity and horizontal portion of ***obturator foramen***.
- The ischium has a large roughened caudal prominence, the ***tuber ischiadicum*** (also ***ischial tuber***), commonly called the ***pin bone*** in cattle and ***sit bone*** in human.





LEFT OS COXAE (IM)

C. Pubis

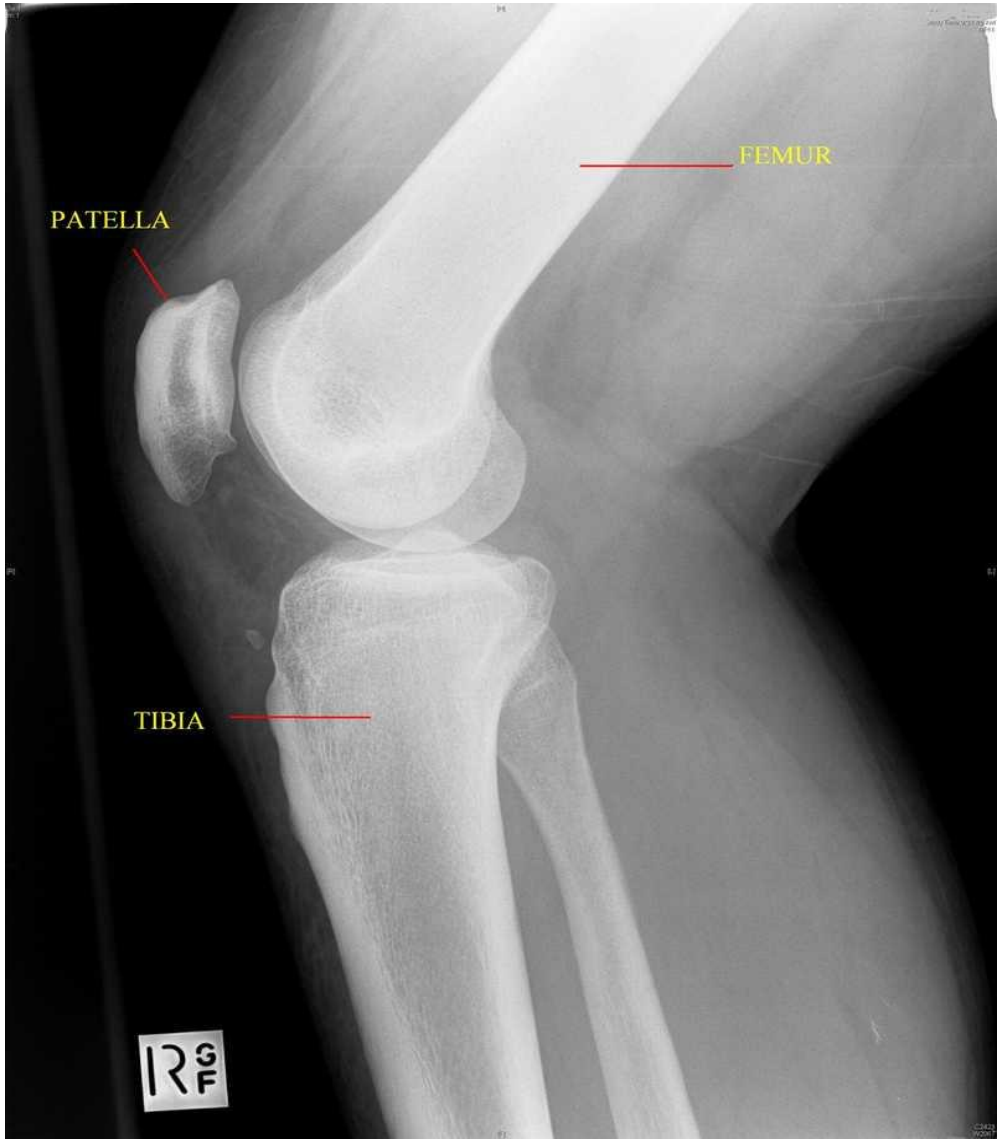
- Is the smallest of the three pelvic bones, forms the cranioventral part of the floor of the pelvic cavity (*os coxae*).
- It consists of a central body and two branches.
- The pubis also enters into the formation of the *acetabulum* and meets the pubis of the opposite side at the symphysis.
- The pubis and ischium form the boundaries of the ***obturator foramen.***

2. Femur

- The femur (thigh bone) extends from the *coxo femoral (hip) joint* to the stifle joint (corresponding to the human knee).
- The proximal extremity consist of the head, neck and *major trochanter*.
- The femur has a nearly spherical head that articulates with the acetabulum of the *os coxae* to form the *hip joint*.
- There is a small depression, the fovea, in the head of the femur that allows for passage of the round ligament of the femur.

- The major trochanter is used for the attachment of heavy thigh and hip muscles.
- The body bears trochanter minor (lesser), third (*tertius*) trochanter and the supra condyloid fossa.
- Third trochanter is not found ruminant and dogs.
- **N.B**: Trochanter is unique for femur.
- The body (shaft) of the femur is nearly circular on cross-section and has considerable length.
- The distal end has two *condyles* for articulation with the tibia and a *trochlea* for articulation with the *patella***.**

- **Patella** a sesamoid bone embedded in the tendon of insertion of the large quadriceps muscle.

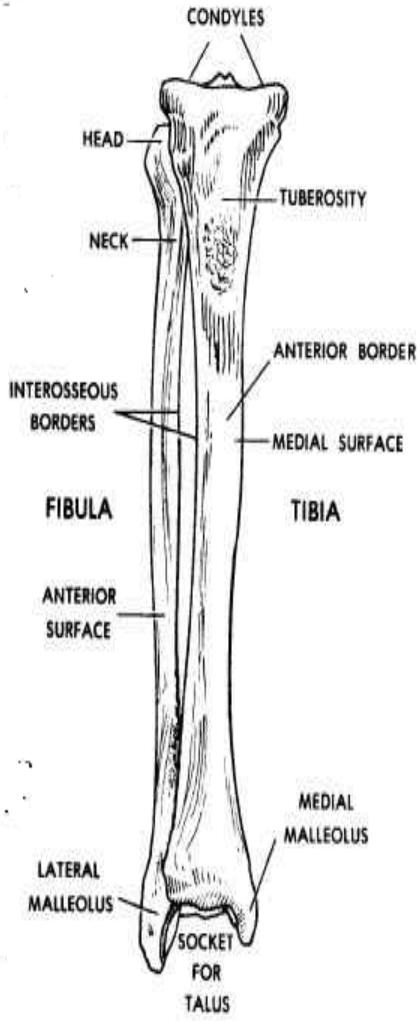


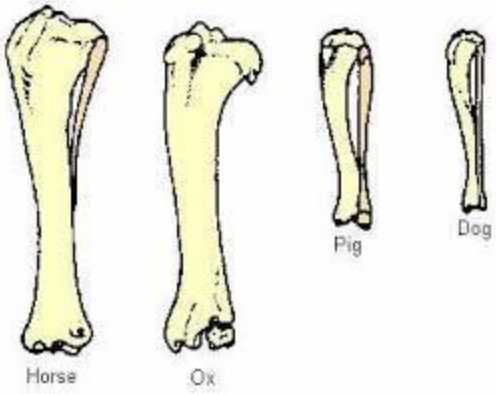
3.Tibia and fibula (leg)

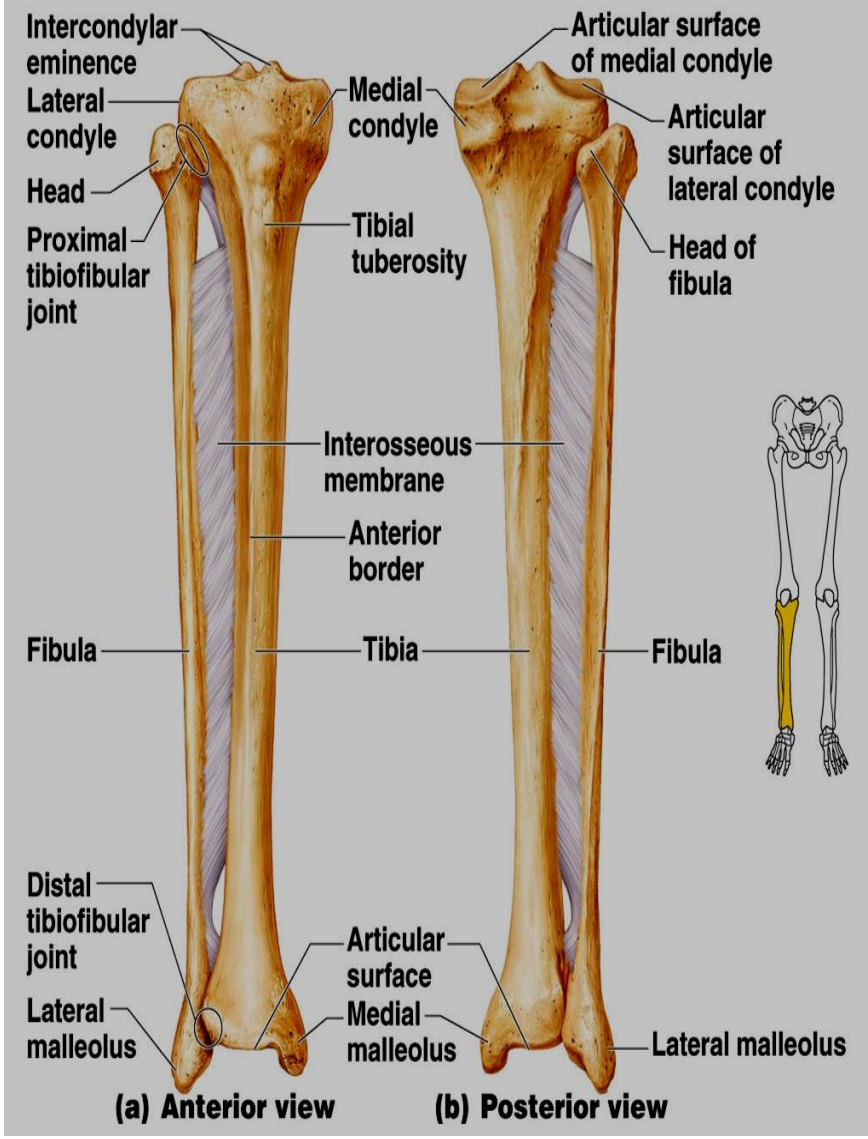
- They are bones of true leg.
- They found between stifle and hock joints.

Tibia

- A long bone which extend obliquely downward and back ward from femur to tarsus.
- The proximal extremity expanded that participates in the *stifle joint*.
- Its shaft is triangular in cross-section.
- Proximal extremity bears a two condyle, intercondylar tubercle and a tuberosity
- Distal extremity bears an articular surface to articulate with tarsal bones ***(talus)*** that form the hinge joint of the hock.


CONDYLES
HEAD
TUBEROSITY
NECK
ANTERIOR BORDER
INTEROSSEOUS BORDERS
MEDIAL SURFACE
FIBULA
TIBIA
ANTERIOR SURFACE
MEDIAL MALLEOLUS
LATERAL MALLEOLUS
SOCKET FOR TALUS


Horse
Ox
Pig
Dog


Intercondylar eminence
Lateral condyle
Head
Proximal tibiofibular joint
Medial condyle
Tibial tuberosity
Articular surface of medial condyle
Articular surface of lateral condyle
Head of fibula
Interosseous membrane
Anterior border
Fibula
Tibia
Fibula
Distal tibiofibular joint
Lateral malleolus
Articular surface
Medial malleolus
Lateral malleolus
(a) Anterior view
(b) Posterior view

Fibula

- Fibula is a long, thin bone extending from the proximal end of the tibia to the lateral aspect of the hock in carnivore, pigs and primates.
- The horse has both the proximal end and a portion of the shaft, whereas only a vestige of the proximal end of the fibula is present in domestic ruminants.
- All domestic species have the distal extremity of the fibula, forming the prominent ***lateral malleolus of the hock.***
- The lateral malleolus is fused to the tibia in the horse but is a separate small bone articulating with distal tibia and tarsal bones in ruminants.
- The fibula of dog and pig is fully developed but smaller than the tibia

4. Tarsus

- Contains a group of short bones, ***ossa tarsi***.
- Numbered from 5-7 in different species. They are arranged roughly in three rows: proximally, central and distally.
- The proximal row consists of two bones: the ***talus*** and the ***calcaneous***.
- The **talus** (tibial tarsal bone) is a large pulley-like mass and has trochlea that articulate with the tibia.
- The **calcaneous** is the largest tarsal bone projects proximal and caudal.
- Located at the fibular or lateral side and has a long bony process known as the **calcanual tuber** or **point of the hock**.
- The calcaneous, which corresponds to the human heel, acts as a lever for the muscles extending the hock.

Left tarsus, articulated, lateral aspect.

Figure 1 from Miller, et al

- The distal row consists of four bones designated numerically from medial to lateral as I, II, III & IV tarsal bones.
- While the central tarsal bone is located b/n the two rows**.**
- Carnivores and pigs have the generalized pattern (has 7 tarsal bones).
- Ruminants: the central & fourth are fused, the 2nd & 3rd are fused=5.
- Horse- the first & second tarsal bones are fused=6.

5. Metatarsus

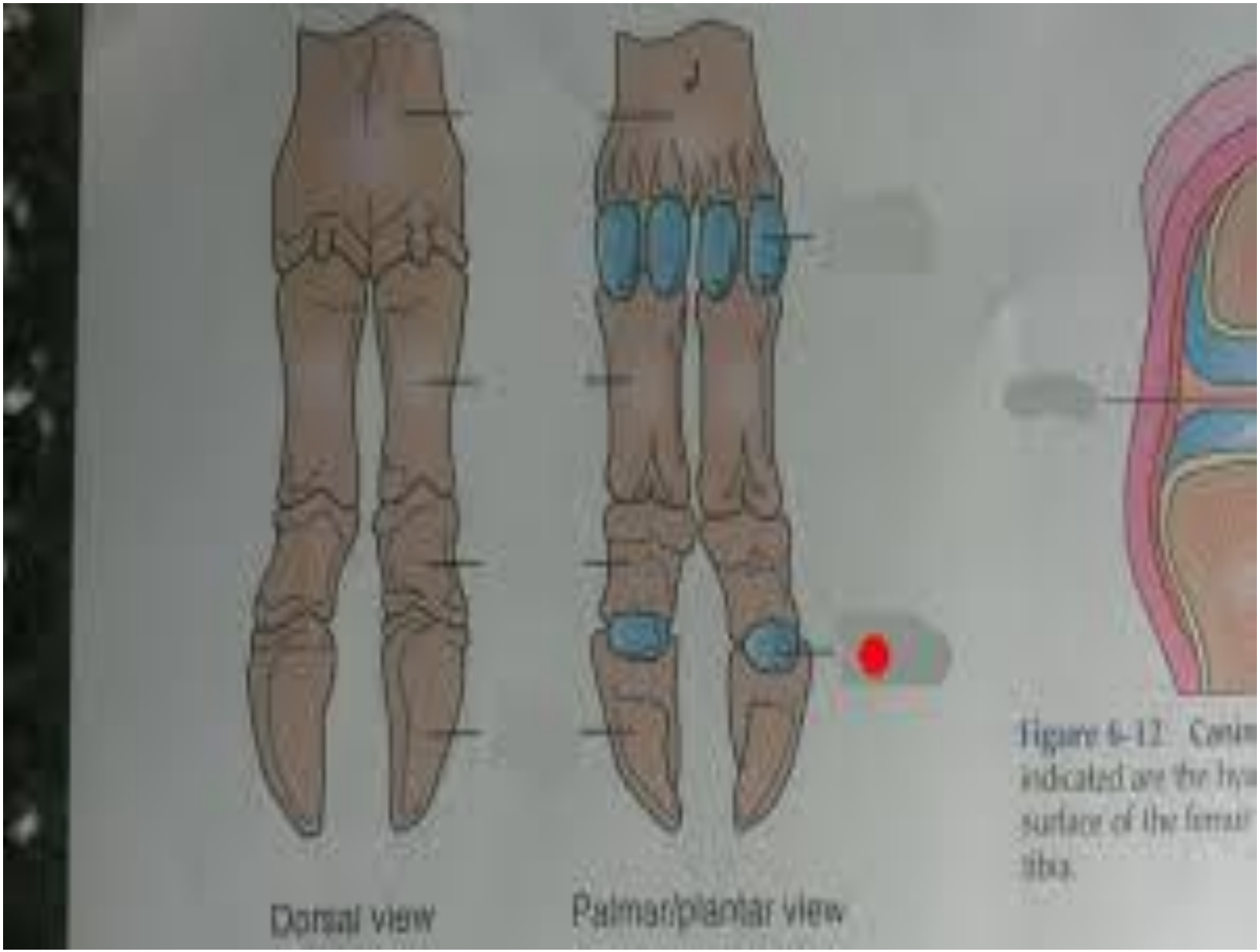
- Are long bones, occur between the distal row of the tarsus and the proximal phalanx.
- Structurally similar to the metacarpals with few exceptions:
  - ✓Metatarsals are **longer and less massive** than the metacarpal bones in most domestic animals.
  - ✓The caudal and cranial surfaces are curved, giving the metatarsal bones **a circular cross section** while **semi circular** in metacarpal.

- In ruminants the difference is the absence of the fifth metatarsal bone.
- The 3rd & 4th are fused, has dorsal and plantar groove, proximal & distal metatarsal canals, inter trochlear notch
- The general pattern is present in carnivores and the 1st metatarsal is markedly reduced & bears no digits & is often fused to the 1st tarsal bone.
- In cats metatarsal are longer than metacarpal bones.

6. The digits (phalanxes and sesamoid bones)

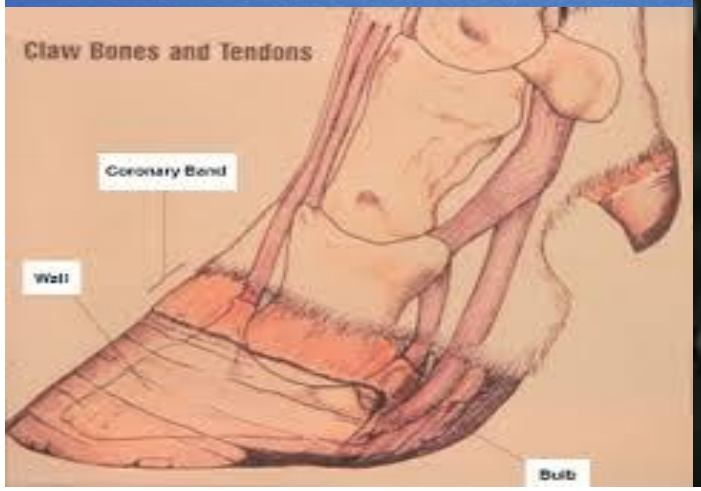
- The chief differences in the form and size of the phalanx bones are as follow:
  - The proximal phalanx is a little shorter, wider proximally and narrower distally.
  - The middle phalanx is narrower and slightly longer.
  - The distal phalanx in the pelvic limb of horse is longer and less rounded than its thoracic limb.
  - The 1^{st} digit in the carnivores is usually absent.

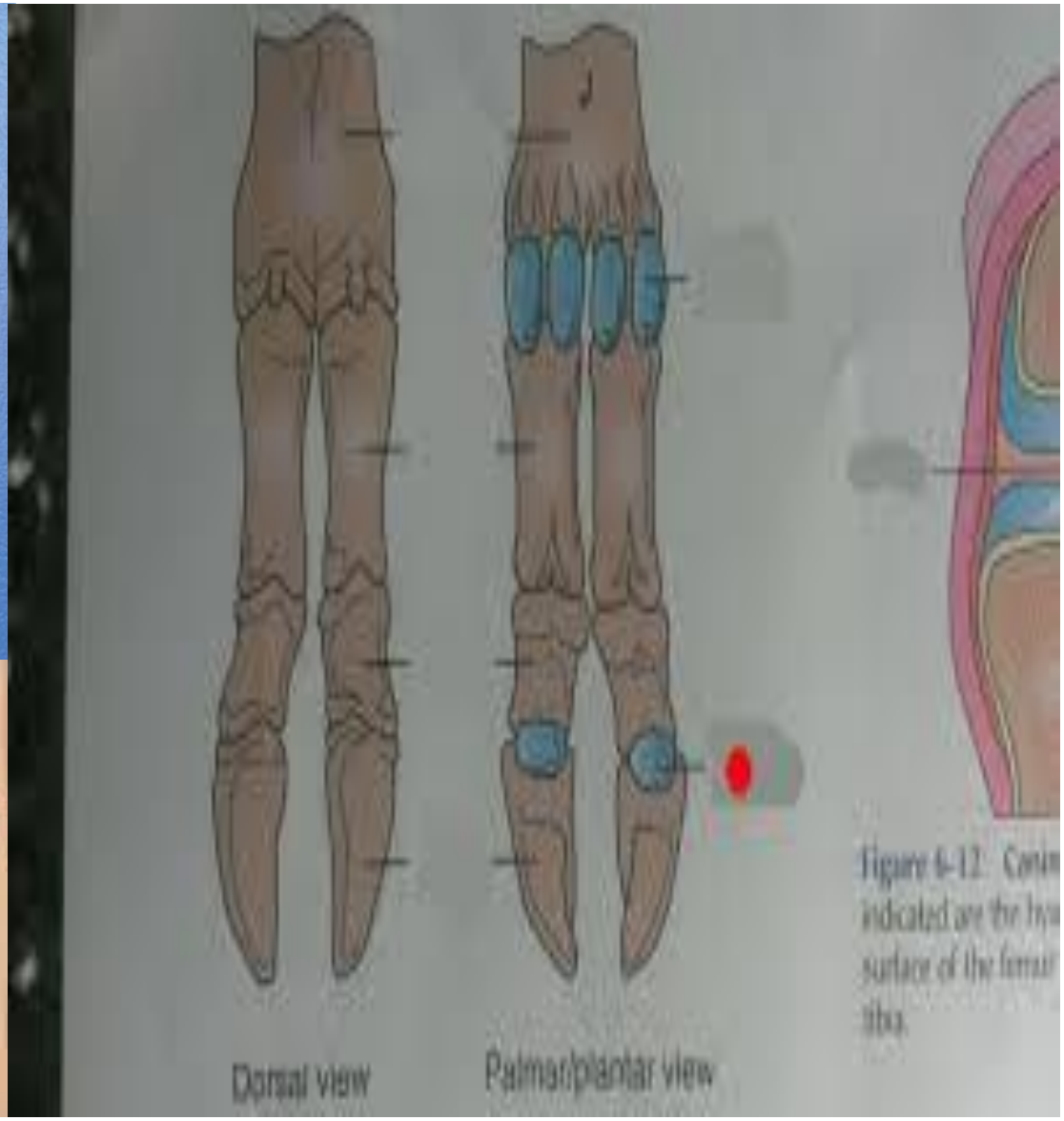
Picture digits and sesamoid bones of ruminants



Sesamoid bones:

- The proximal sesamoids are a little smaller, except in thickness, than those of the thoracic limb.
- The distal sesamoid is narrower and shorter.
- The patella is the largest sesamoid bone in the body**.**
- The ruminants and pig have metatarsal sesamoid bone on the plantaromedial aspect of the proximal metatarsal region.


Claw Bones and Tendons
Coronary Band
Wall
Bulb

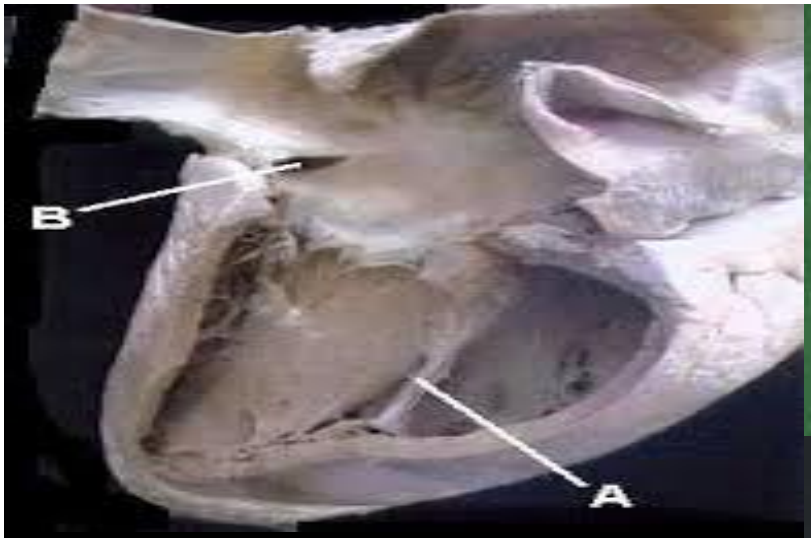

Dorsal view
Palmar/plantar view

3. VISCERAL(SPLANCNIC) SKELETON

- The visceral skeleton consists of the bones that are developed in soft tissues of certain organs such as the heart and the penis.

Example

- *Os cordis* in the heart of Ox; *Os penis* in the penis of the dog and *Sclera ring* in the eyes of the birds.


B
A

ARTHROLOGY(SYNDESMOLOGY)

Lecture notes

Definition:

- **Arthrology (syndesmology)** is the study of the ***articulations (unions) between bones,*** which are commonly called ***joints.***
- **Joints** (articulations, arthroses) may be simply defined as the places where two or more bones and/or cartilages connect.
- Joints are vital to allow for the movement of the skeleton.

<u>Importance</u>

- In the understanding of the anatomy and physiology of the joints and abnormalities observed during disease conditions.
- To identify proper sites for treatment of the joint diseases and for taking samples for diagnostic purposes.

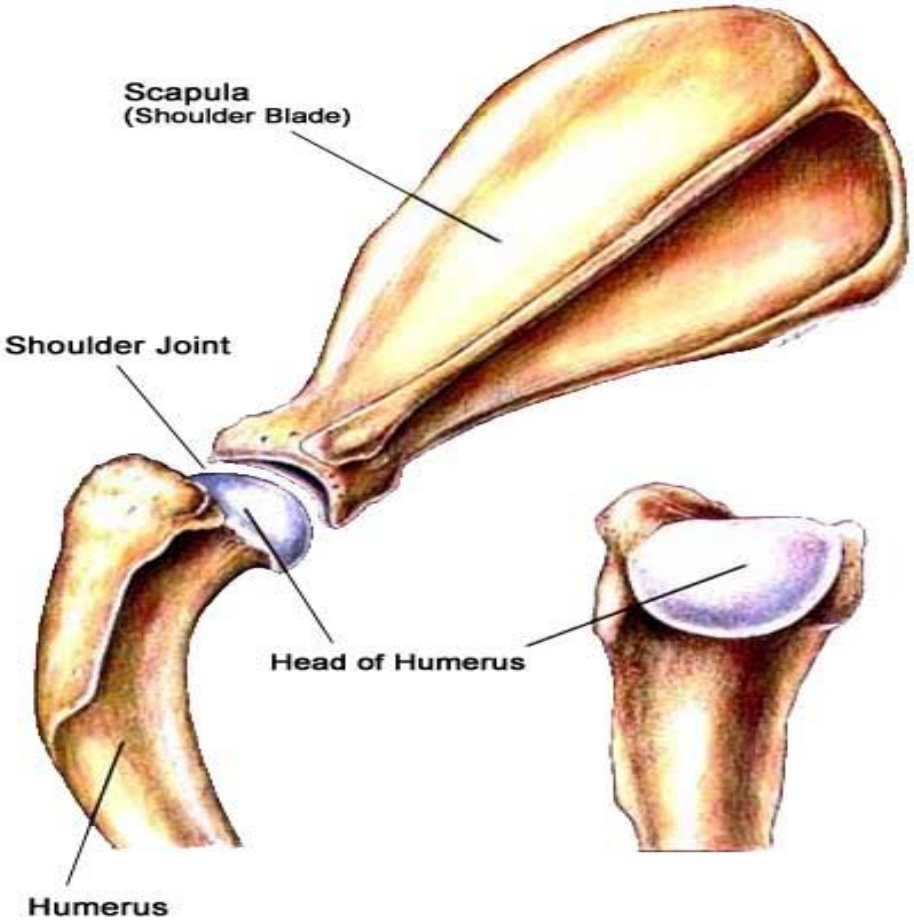
Names of Joints

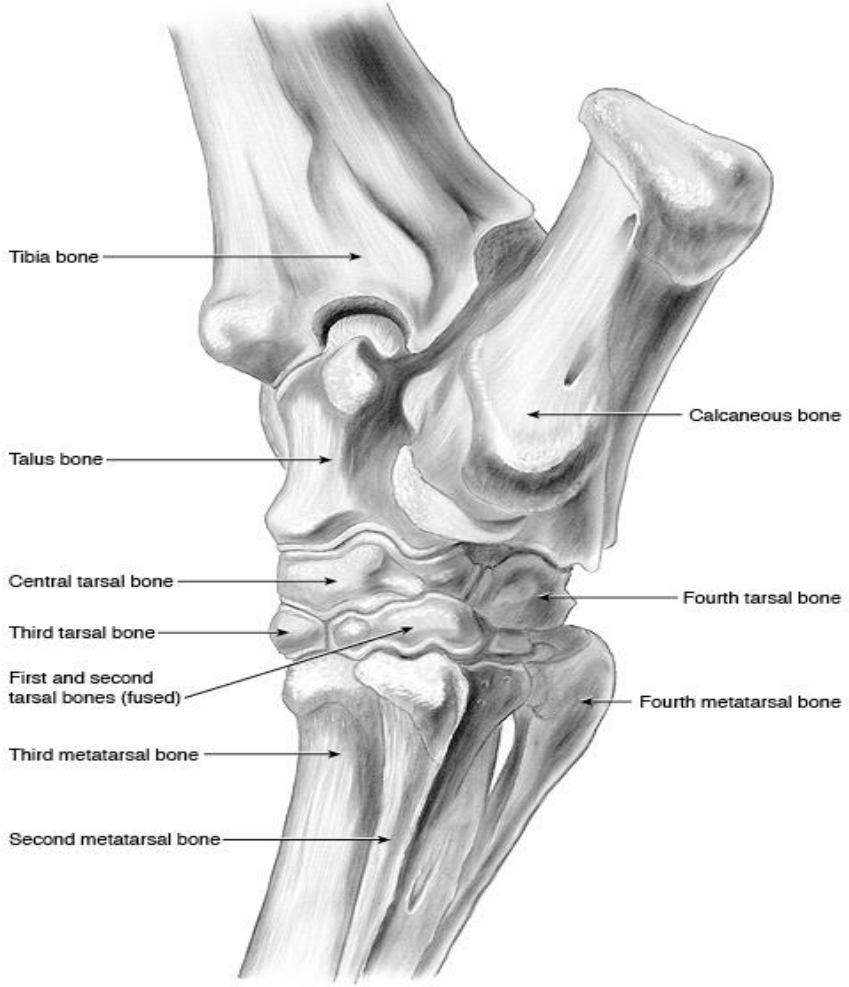
Anatomical names	Common names		
	Human	**Dog**	**Horse**
Scapulohumeral	Shoulder	Shoulder	Shoulder
Humeroradioulnar	Elbow	Elbow	Elbow
Antebrachiocarpal	Wrist	Carpus	Knee
Carpometacarpal	Wrist	Carpus	knee
Metacarpophalangeal	Knukle	Paw/foot	Fetlock
Middle interphalangeal	Knukle	Paw/foot	Pastern
Distal interphalangeal	Knukle	Paw/foot	Coffin
Coxofemoral	Hip	Hip	Hip
Femorotibial	Knee	Stifle	Stifle
Tibiotarsal and tarsal bones tarsus/hock	Ankle	Tarsus/Hock	Hock
Metatarsal and digits same as metacarpal and digit terminology			

Joints can be classified in several ways including:

1) The number of articulating bones,

- Simple (two bones) and compound (more than two bones) joint.





2) Structural classification (based on medium holding together):

- Fibrous joint (immovable)
- Cartilagous joint (slightly movable)
- Synovial joint (movable)

3. Functional classification (based on degree of mobility of joints)

- Synarthrotic- movement are absent or extremely limited
- Amphiarthrotic-slight movement
- Diarthrotic-considerable movement

Note: The amount and kind of movement are determined by the **shape** of joint surfaces, and amount and pliability of the uniting medium.

STRUCTURAL CLASSIFICATION

1.Fibrous joint

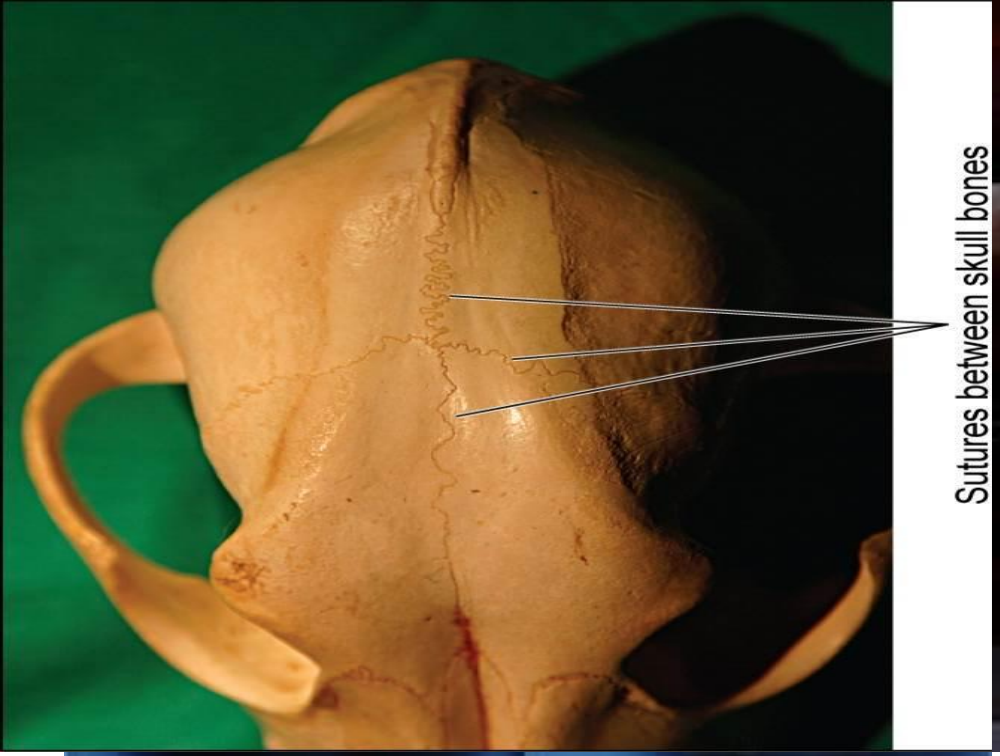
- Have no joint cavity**.**
- The bones are united by fibrous tissue

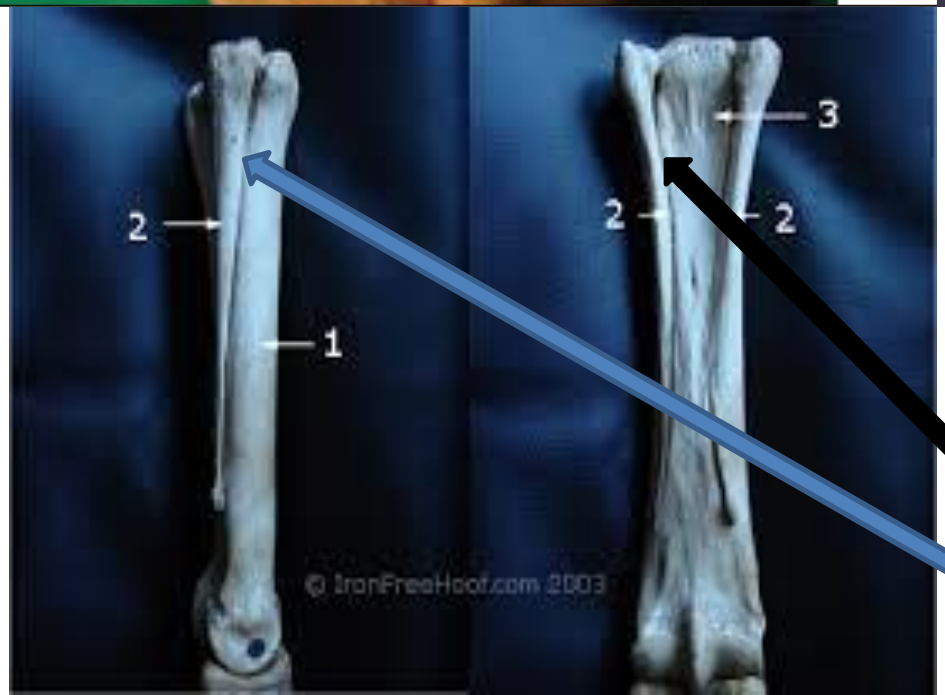
***1. Syndesmosis*:** refers to a joint united by fibrous tissue that permits only slight movement.

- In these, uniting medium is **white fibrous** or **elastic tissue** or **a mixture**
- Example, the normal union of the shafts of the splint bones and cannon bone of the horse.

2. Suture (immovable joint): is the particular fibrous joint between bones of the skull.

- Suture in which bones are tightly bound together by fibrous connective tissue so as to prevent movement between them.



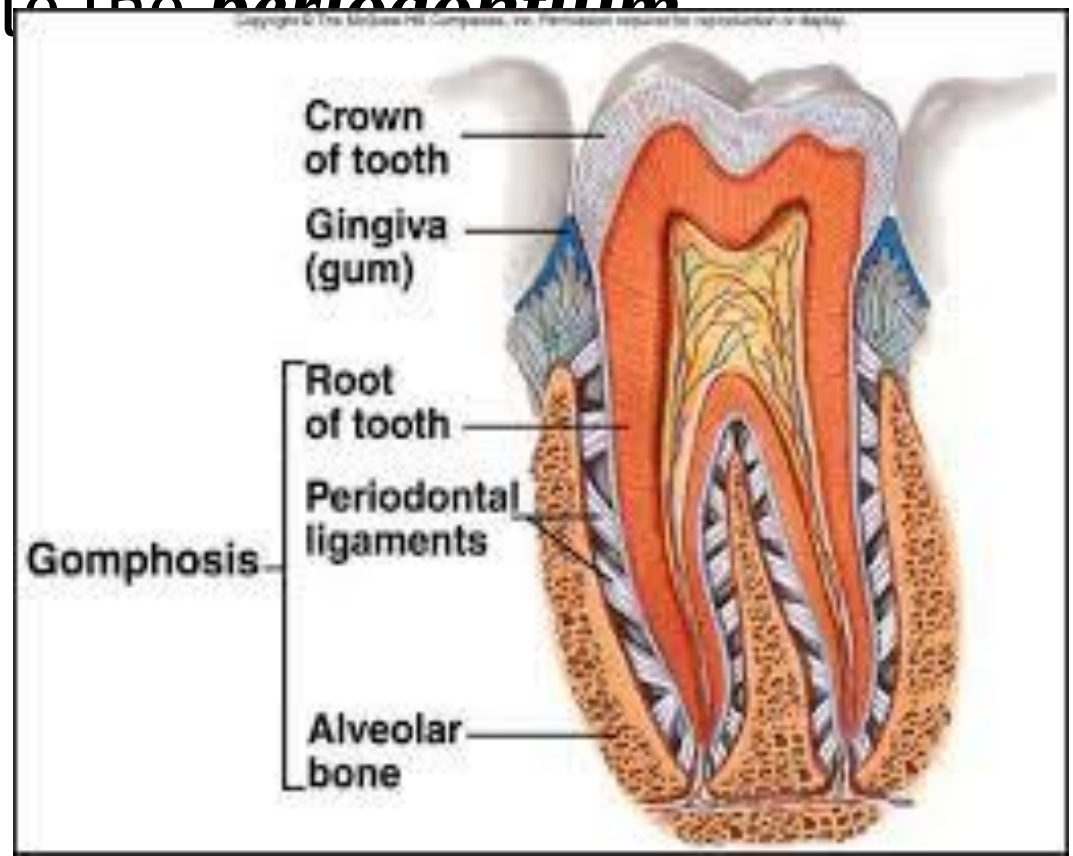


Syndesmosis

- Sutures often completely ossify in maturity. No movement is there.

3. *Gomphosis* is the specialized articulation of teeth in their alveoli (sockets) in the mandible and maxilla.

- The collagenous tissues and fibroblasts mediums of union constitute the ***periodontium***



2. Cartilaginous Joints

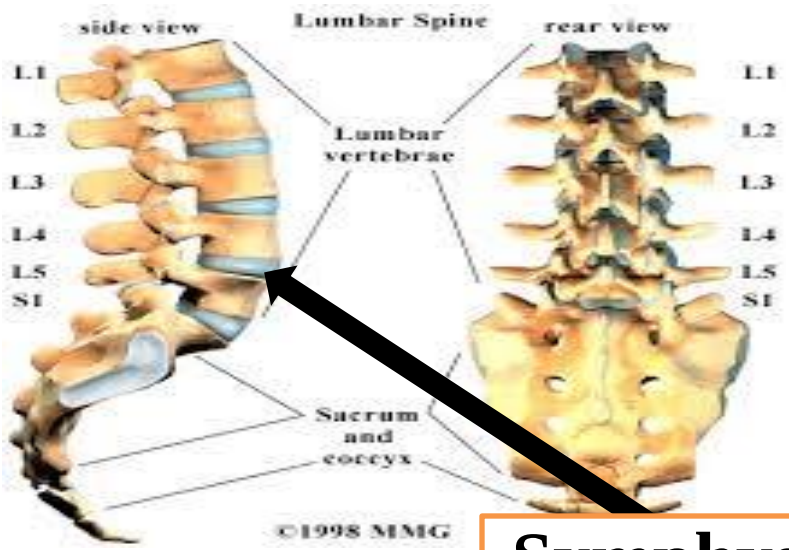
- Are united by cartilage, with no intervening joint cavity.

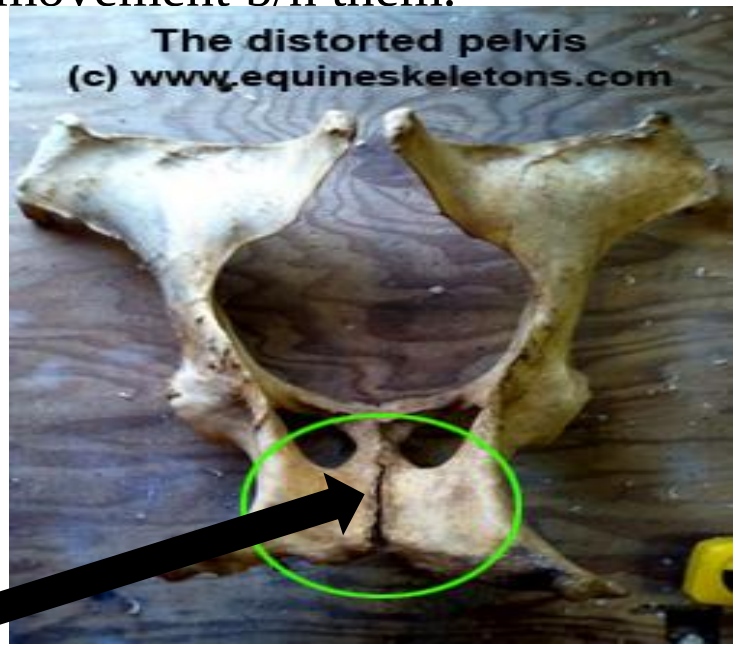
a. ***Synchondrosis*** is an immovable joint in which the uniting medi

- The union s of an immature bo

b. *Symphyses (fibrocartilaginous joints)*: are united by flattened disks of fibrocartilage

- Found between adjacent pelvic bones and between the bodies of adjacent vertebrae , b/n sternebrae and b/n bodies of mandible.
- There is very **little** and **variable** amount of movement b/n them.



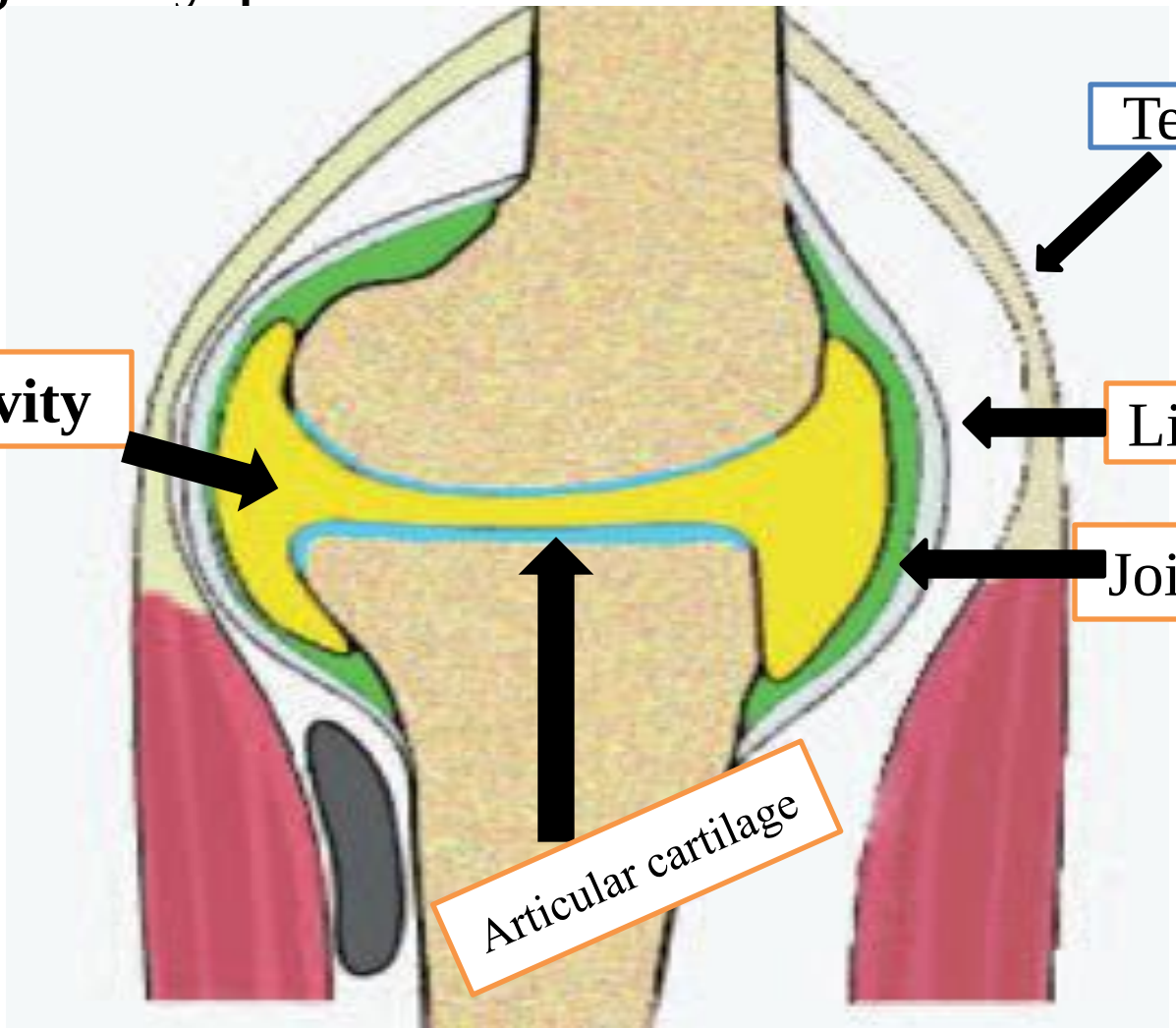


Symphysis

- The fibrous or cartilaginous tissues separating adjacent bones in **syndesmoses**, **synchondroses**, and **symphyses** can be replaced by bone as a result of either aging or degenerative processes which sometimes called **synostosis**.

3. Synovial joints

The synovial joint is movable, complicated joint, involving many parts.



Includes:

The articular surfaces are specialized layers of compact bone on the surfaces that articulate with other bones.

The articular cartilage is a layer of hyaline cartilage covering the articular surface.

- ✓ It is **insensitive (no nerves**) and **a vascular.**
- ✓ the **insensitivity** explains why joint lesions may progress far before the patient becomes aware of their existence

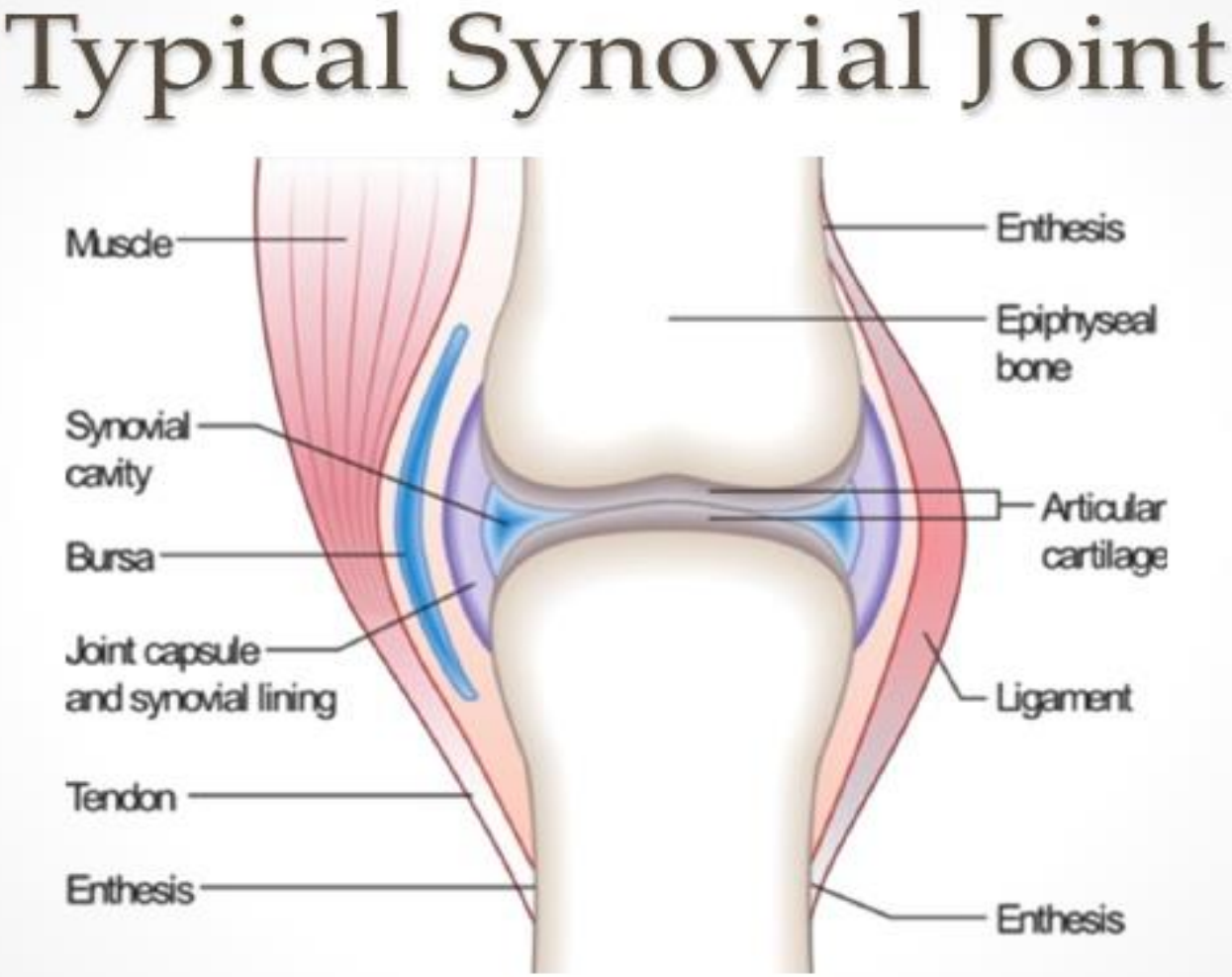
The articular cavity is a space between the adjacent bones of the joint surrounded by the joint capsule.

Bursa is a small, fluid filled sac lined with synovial membrane.

- ➢ Bursae act as cushions and are generally found where tendons cross over a bony prominence.

Note: Nutrient and oxygen requirement are met articular cartilage by diffusion from 3 different sources

- Fluid in joint cavity
- Vessels at the periphery of the cartilage, and
- Vessels in the adjacent marrow spaces



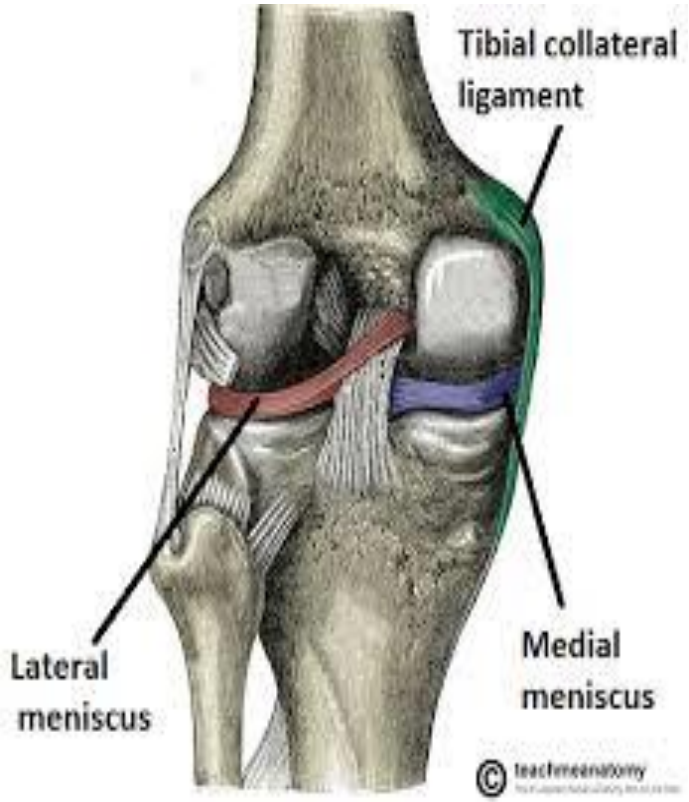
Joint capsule consists of two layers: synovial membrane, and an outer fibrous layer.

- **Synovial membrane:** a delicate layer of specialized connective tissue extending from the edges of the articular cartilages of the adjacent bones but not covering the articular cartilage.
  - It richly supplied by blood vessels and nerves & forms folds & villi, which project into the cavity
- **Fibrous capsule:** the superficial layer of the joint capsule and is a heavier fibrous sleeve adjacent to the synovial membrane.
- **Synovial fluid** is viscous fluid secreted by synovial membrane and acts to lubricate the joint, provide nutrients, and remove waste from the hyaline articular cartilage.

Ligaments: are connective tissue bands in relation to the musculoskeletal system, that extend from bone to bone.

- ***Intra capsular (intra articular) ligaments*** are found within joints and are surrounded by the synovial membrane. The cruciate ligaments of the stifle are intra capsular ligaments.
- ***Extracapsular (peri-articular) ligaments*** are external to the joint capsule; they include collateral, dorsal, palmar, plantar, and annular ligaments.
- ***Collateral ligaments*** lie on the medial and lateral aspects of a joint.

- ***Dorsal and palmar*** (or ***plantar) ligaments*** lie in front of and behind the joint.
- ***Annular ligaments*** surround the joint, and their fibers generally circle the joint to strengthen and protect the capsule.



Palmar aspect
(no ACB)

Plantar intercarpal ligaments

1-2 RCB and Radius

3 ICB and Radius

4 Stump of ligament connecting ICB and ACB

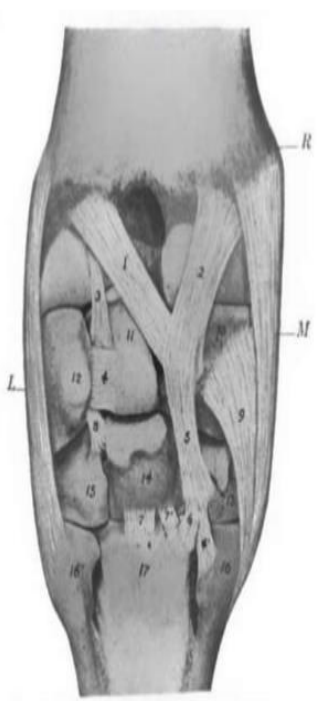
5 RCB and IICB (med palmar intercarpal lig)

6 IICB and IIIMB

7 IIICB and IIIMB

8 Ulnar and III and IVCB (lateral palmar intercarapal lig)

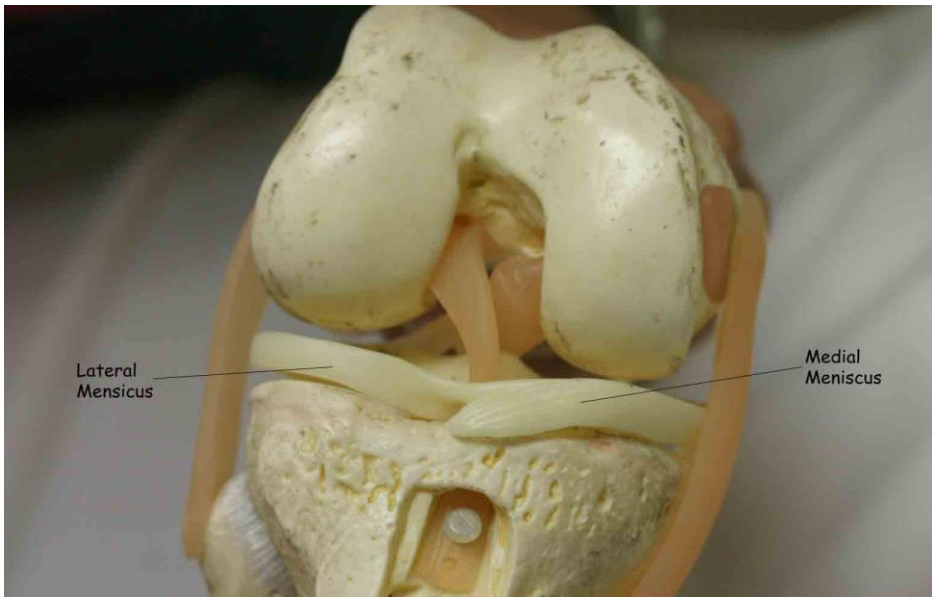
9 Short MCL



Accessory Structures Found in Certain Synovial Joints

- **Tendons**: are connective tissue bands that connect muscle to bone.
  - It protected from bony prominences by a synovial membrane that wraps around the tendon's circumference called ***synovial sheath***.

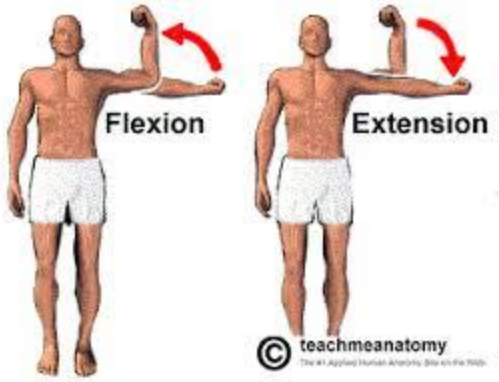
- ***Menisci (fibrocartilage disks)*** are truly intra capsular interposed between surfaces of some joints, where they contribute to the congruency of the articular cartilages and probably play a role in complex joint movements.
- Prominent menisci are found in the stifle and the temporomandibular joint.

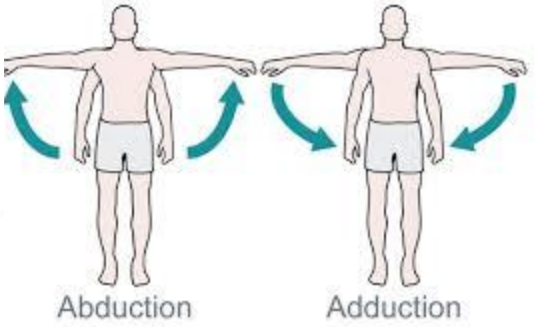


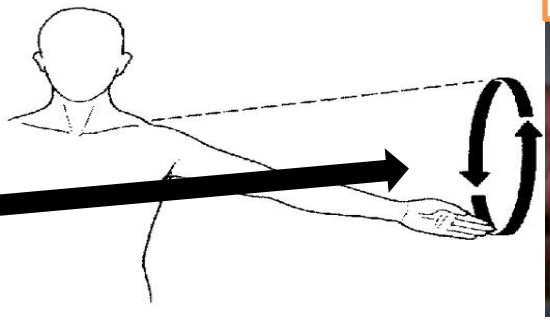
Movements of Joints

Synovial joints may exhibit one or more of the following movements:

- Gliding or sliding
- Flexion,
- Extension,
- Hyperextension,
- Rotation,
- Adduction,
- Abduction and
- Circumduction







Rotation

- ***Gliding or sliding:*** movement occurs between two more or less flat surfaces in plane joints.
- ***Flexion:*** is movement in the sagittal plane that tends to decrease the angle between segments making up a joint.
- ***Extension:*** is the reverse of flexion and is movement in the sagittal plane that tends to increase the angle between segments forming the joint.
- ***Hyperextension*** is movement in which the angle between segments is increased beyond 180° (a straight line). E.g., fetlock joint.

- ***Rotation*** consists of a twisting movement of a segment around its own axis. E.g., between atlas and axis.
- ***Adduction*** is movement toward the median plane.
- ***Abduction*** is movement away from the median plane.
- ***Circumduction*** combines the other types of movement with the exception of rotation;

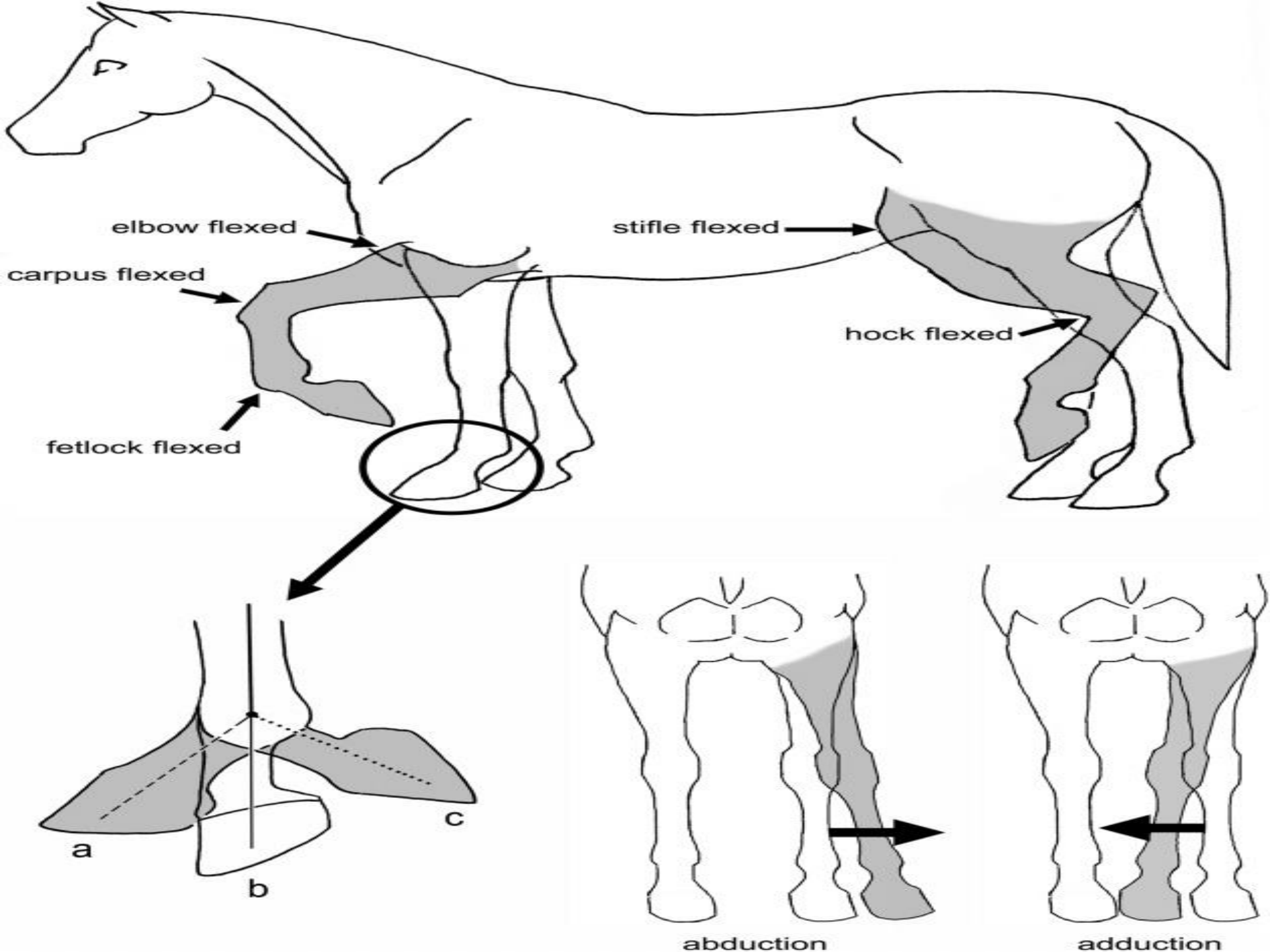
➢ It may be defined as a movement in which an extremity describes a cone, with the distal end of the extremity describing a circle.

Pronation rotates an extremity so that the dorsum is up.

Supination is a movement that rotates an extremity so that the palmar or plantar aspect of the limb is up.

Pronation and supination are rarely seen to any extent in domestic animals.

Protraction - "extension" anteriorly (horizontal).
Retraction - "flexion" posteriorly (horizontal).


elbow flexed
carpus flexed
fetlock flexed
stifle flexed
hock flexed
a
b
c
abduction
adduction

Classification of synovial joints

Synovial joints can be classified in many ways:

1. **Based on the number of bones involved**:

Simple joint: formed by two bones, e.g., shoulder joint

Compound joint: formed by more than two bones, e.g. elbow joint, carpal joint

B. Based on shape of joint surfaces and types of movements

Uniaxial (one orthogonal)

- Plane joint
- Hinge Joint
- Pivot joint

Biaxial (two orthogonal)

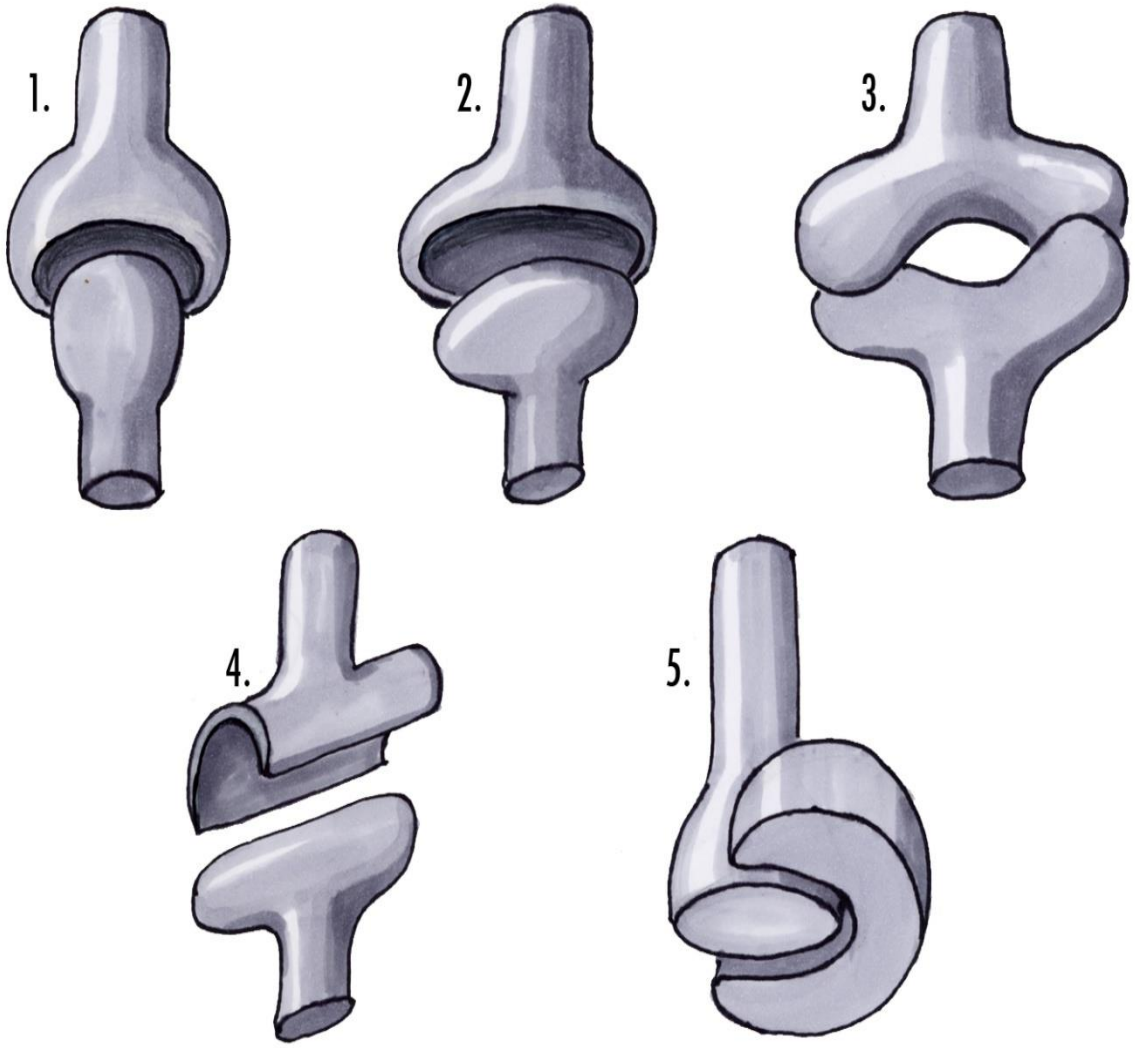
- Condyloid (ellipsoidal) joint
- Saddle joint

Multiaxial (three orthogonal axes)

- Ball-and-socket joint

1. **Ginglymus (hinge)**: joints move only in their sagittal plane.

- Cylindrical projection of one bone fits into trough like depression of other bone;
- Freely movable but restricted to flexion and extension, sometimes hyperextension.
- The knee, elbow, and inter phalangeal joints are good example of a ginglymus joint.



1. Ball and socket
2. Condyloid joint
3. Saddle joint
4. Hinge joint
5. Pivot joint

2. Plane joints

- Articulating surfaces essentially flat; freely movable, but only slipping or gliding motions possible.
- The joints between adjacent carpal bones and tarsal bones are examples of plane joints.

3.Pivot (trochoid) joint

- is one in which rotary movement occurs around one axis.
- Rounded end of one bone projected into sleeve or ring on another bone; freely movable but allows only uniaxial rotation

4. Spheroid (ball and socket) joints

- A spherical head on one bone fits into a cup-shaped depression in the other.
- Permit all possible movement in nearly any direction.
- The coxo femoral (hip) joint is the best example of a spheroid joint.

5. Condyloid (ellipsoidal) joint

- Both articulating surfaces are oval.
- Freely movable allowing flexion, extension, abduction, adduction, and circumduction.
- Best example is radio carpal joints.

6. Saddle joint

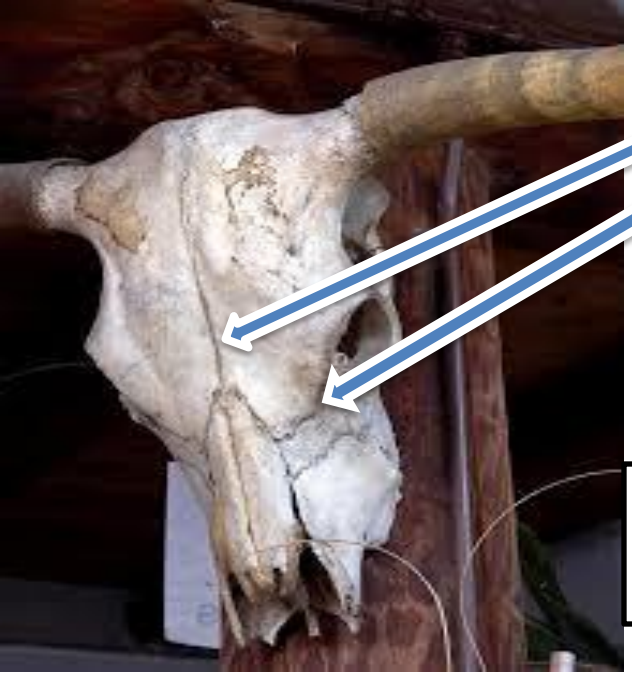
- Each articulating surface has both concave and convex areas, resembling a saddle; freely movable.
- Carpometacarpal joint of thumb in man.

Joints of regional skeleton

1. Joints of Axial Skeleton

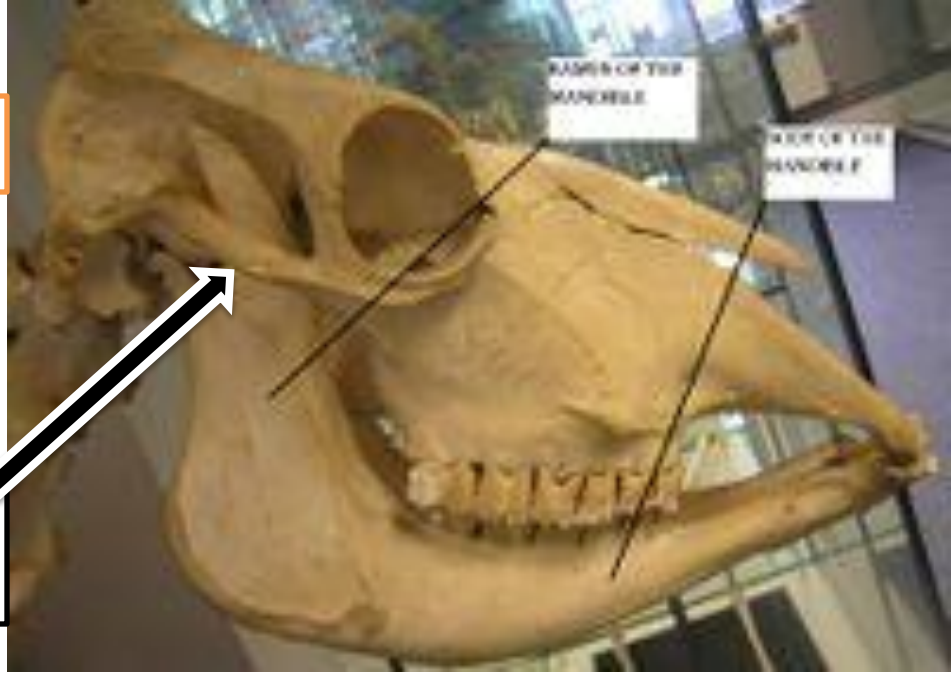
Joints on Skull

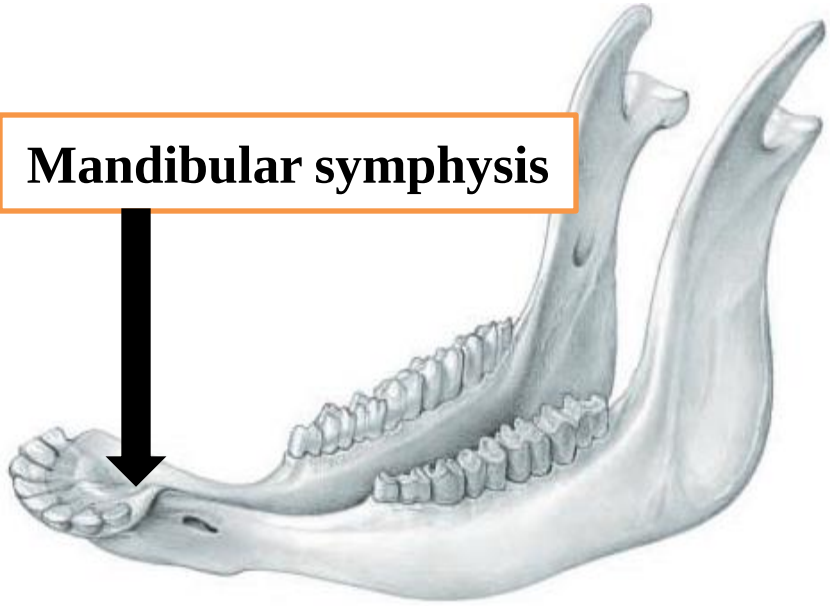
- Are chiefly **sutures** types of joint (braincase and upper jaw of facial part), with adjacent bones united by fibrous tissue.
- In old age these typically ossify, becoming **synostoses**.
- **Symphysis joint** between of the bodies of mandible



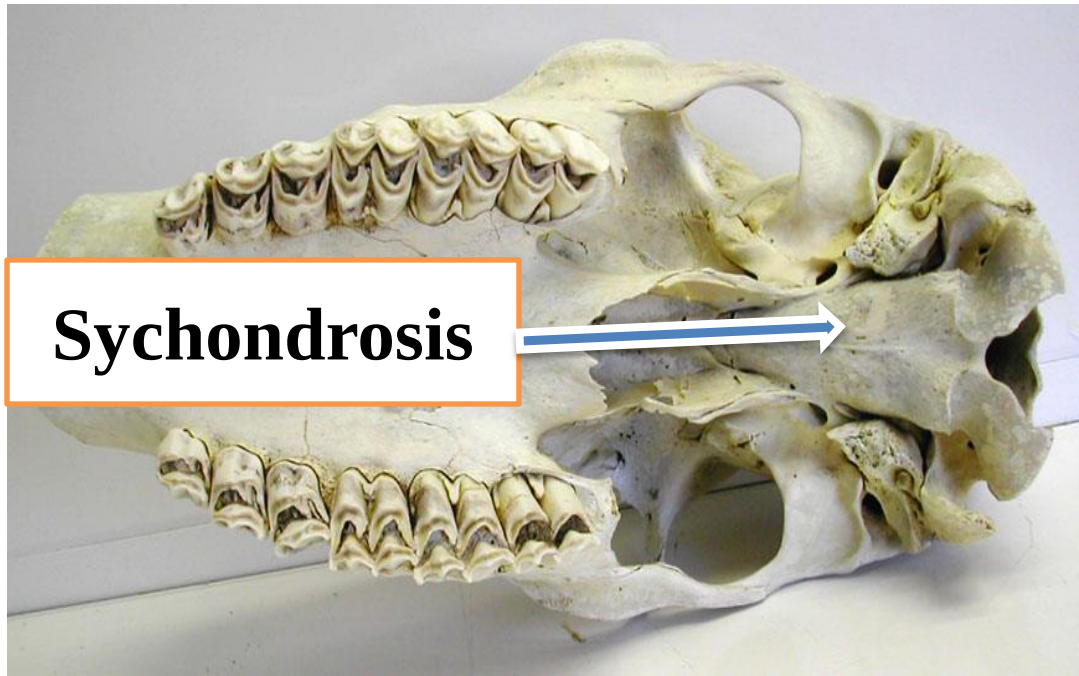
Suture

Ginglymus joint





Mandibular symphysis

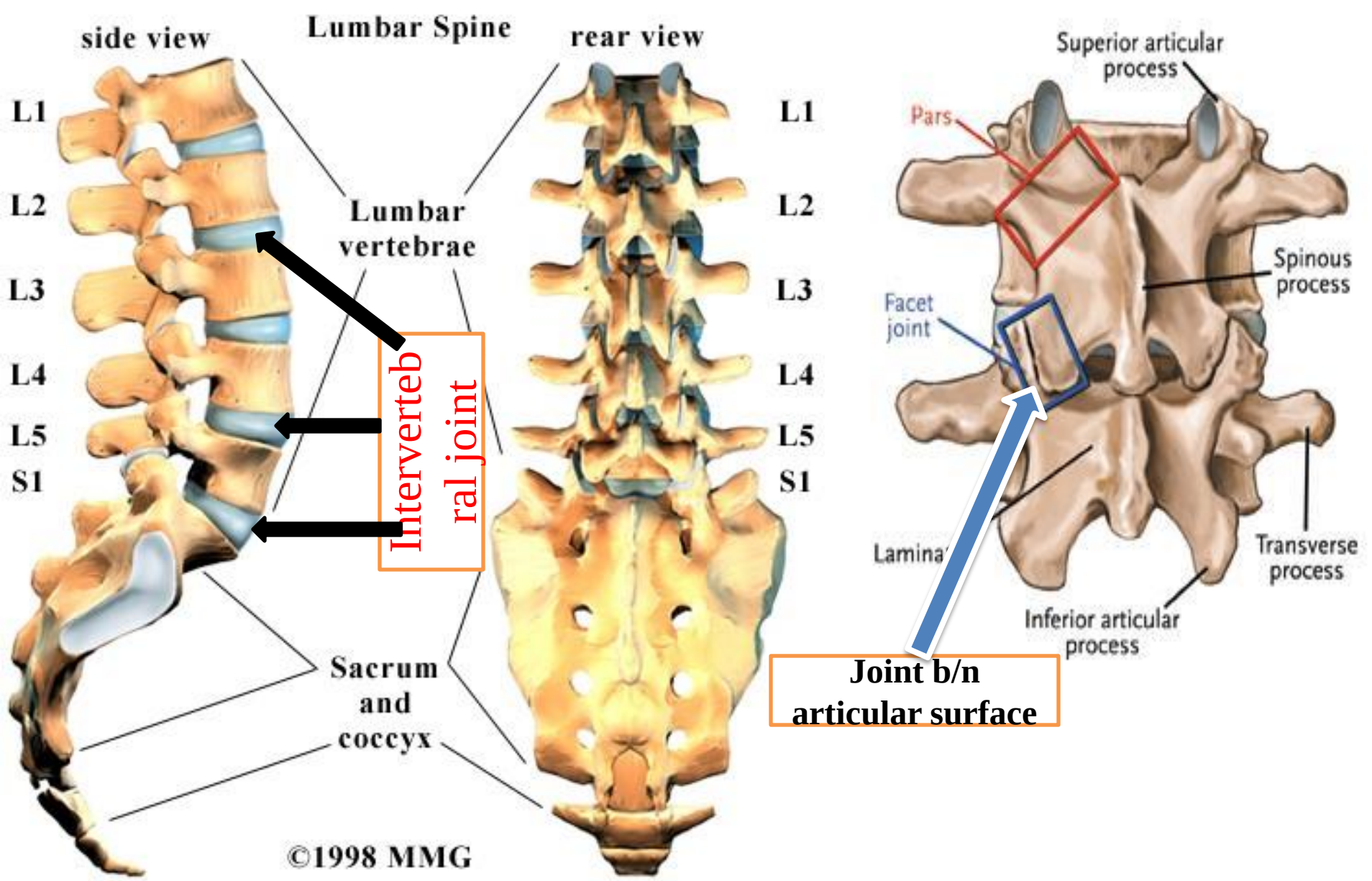


Sychondrosis

- The **synchondrosis** at the junction of the sphenoid bone and occipital bone at the base of the skull, and
- The **ginglymus joint** between squamus temporal bone and condyloid process of mandibular rami (temporomandibular joint) as well as between the occipital bone of the skull and first cervical vertebra (the atlas) (atlanto-occipital joint).

Joints on the Vertebrae

- The intervertebral articulations consist of cartilaginous and synovial joints.
- The **cartilaginous joints (symphyses):** are formed by the intervertebral discs joining the bodies of the vertebrae.
- The **synovial joints** are formed by caudal and cranial articular processes of the adjacent vertebrae (**plane**) as well as between the dens of the axis and the caudal articular surfaces of the atlas (**atlanto-axial joint = pivot**).
- The joints between sacral vertebrae fuse completely, and the sacrum becomes a single bone with the segments joined by **synostoses**.

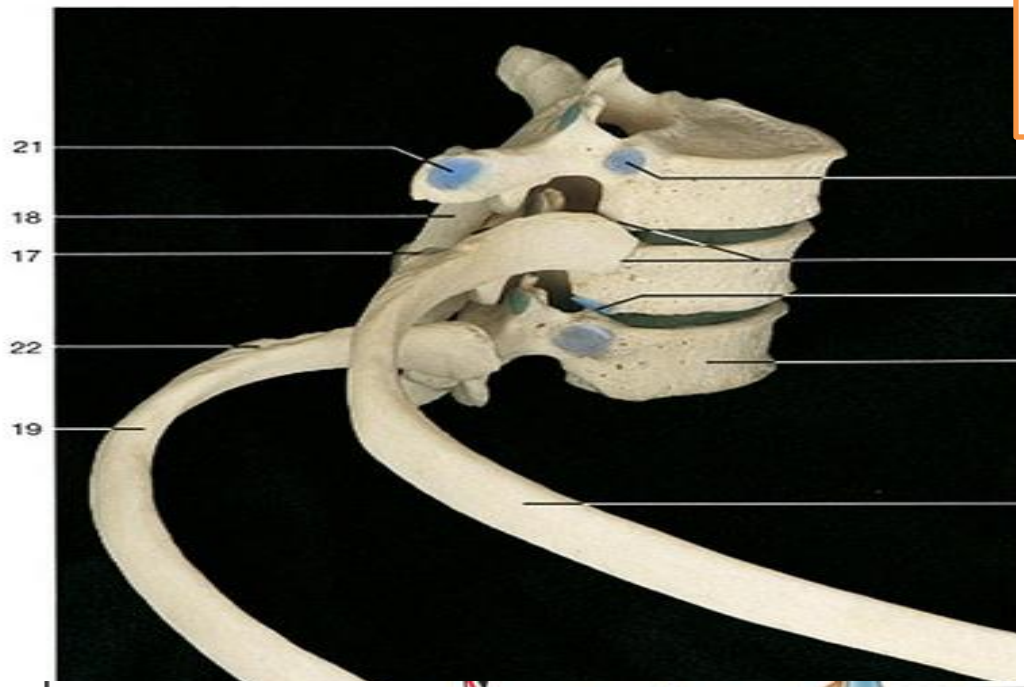

side view
Lumbar Spine
rear view
L1
L2
L3
L4
L5
S1
Lumbar vertebrae
Intervertebral joint
Sacrum and coccyx
©1998 MMG
Superior articular process
Pars
Spinous process
Facet joint
Lamina
Transverse process
Inferior articular process
Joint b/n articular surface

Costovertebral joints: there are two types of articulations between the ribs and the vertebral column.

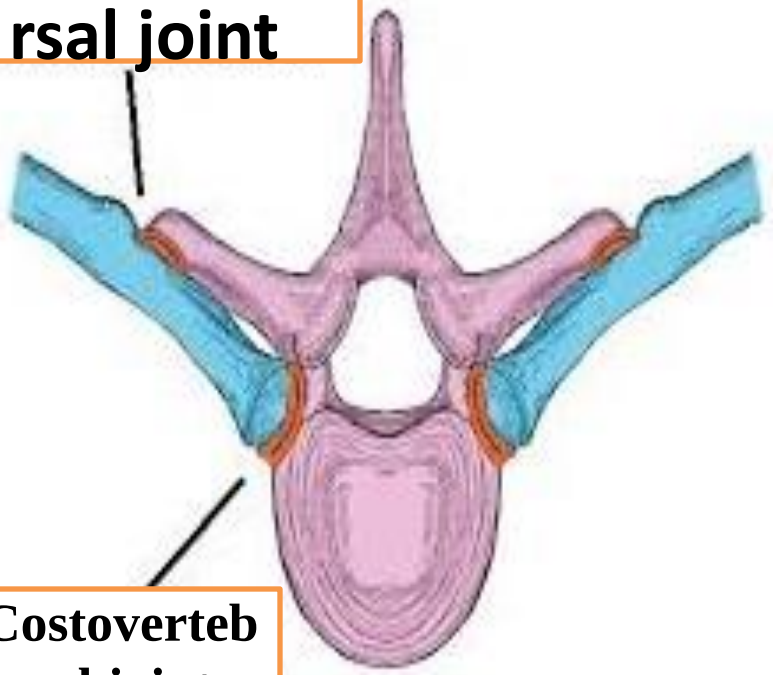
- The head of each rib forms **a ball-and-socket type** of synovial joint, with the coastal fovea of adjacent vertebrae.
- The tubercle of each rib forms a **plane type** of synovial joint with the transverse process of the corresponding rib.

Sternocostal joints: there is a **pivot type** of synovial joint between the first eight costal cartilages and the sternum.

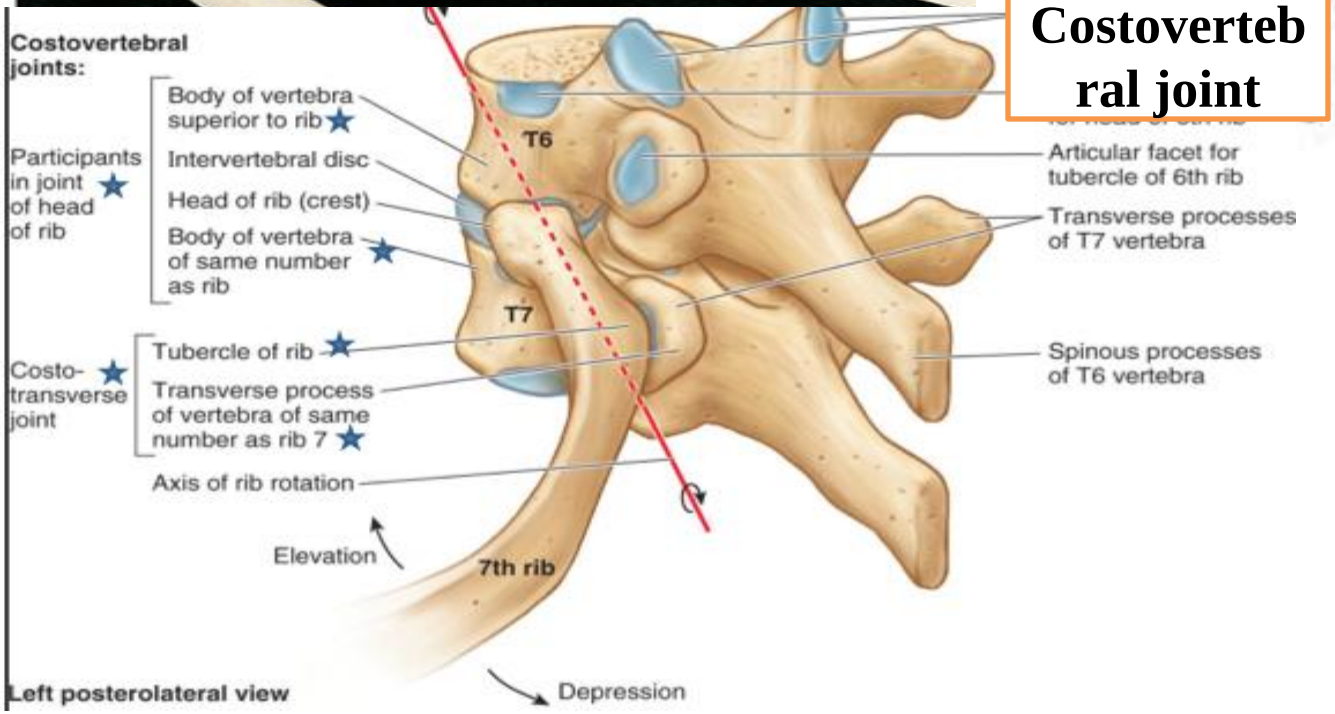
- Each joint has a joint capsule and ligaments



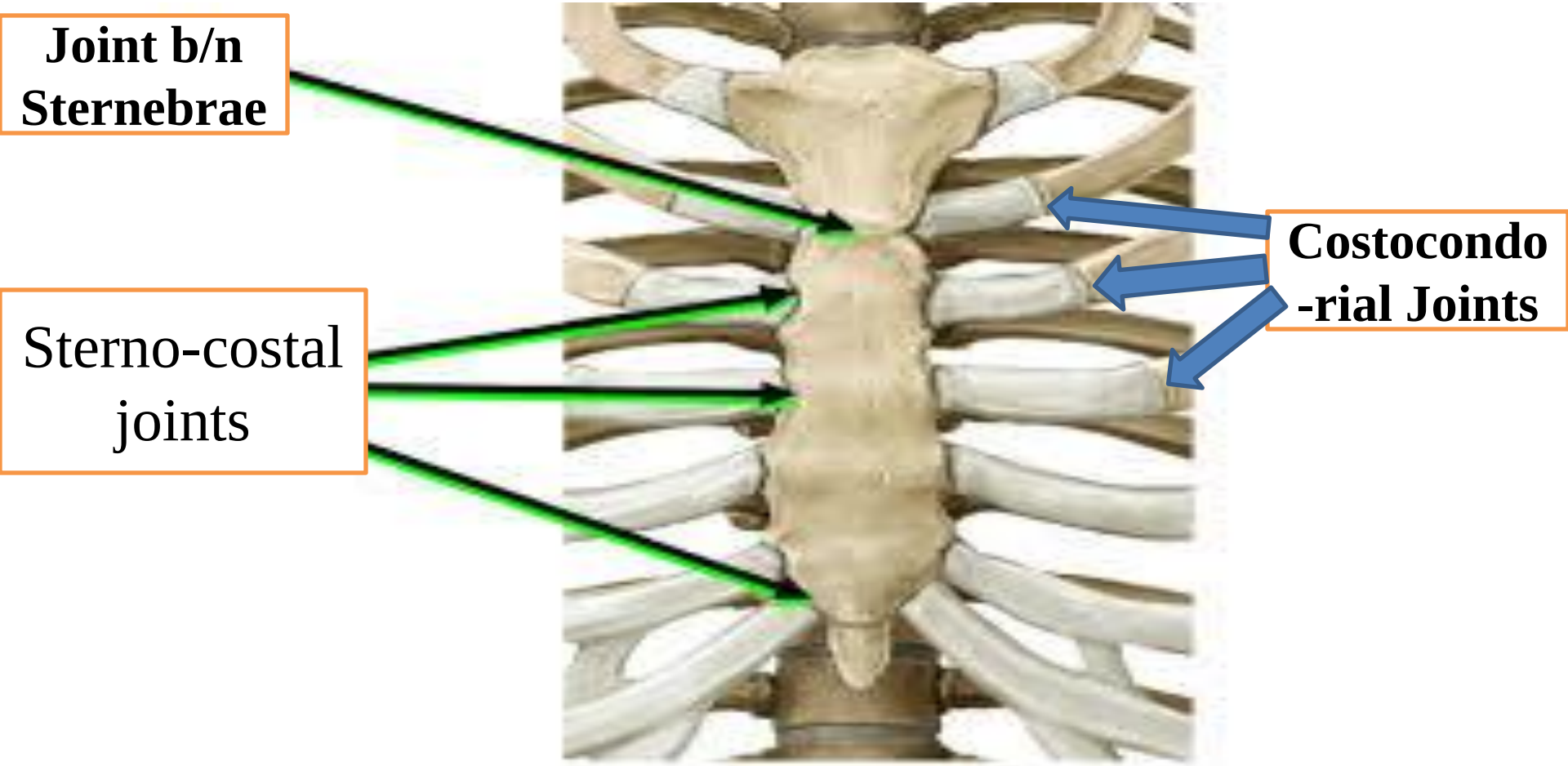
Costotranverse rsal joint



Costoverteb ral joint



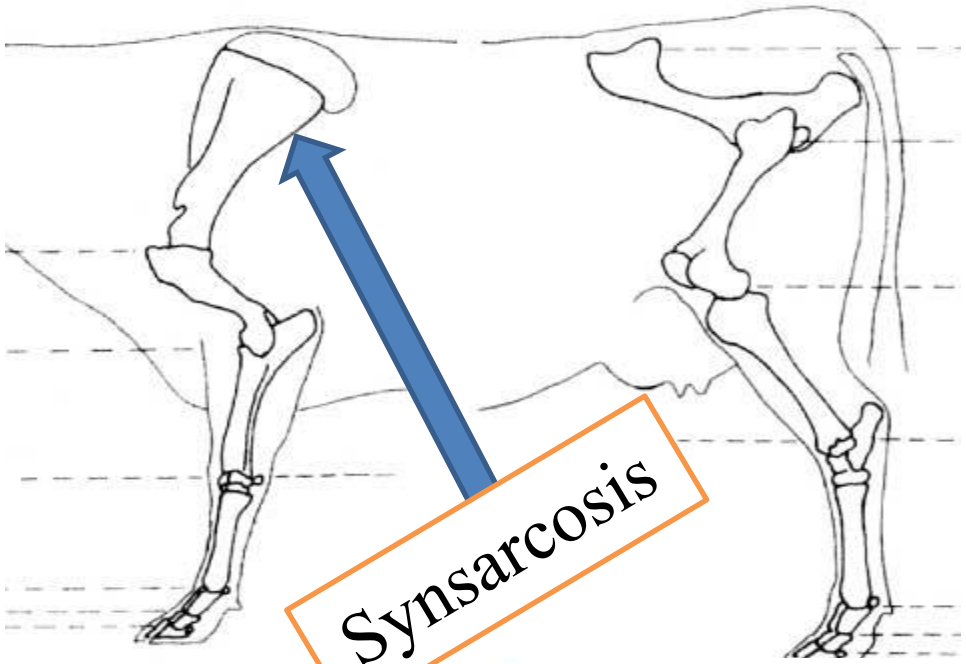
Costochondral joints: there is a **fibrous joint** between the ribs and costal cartilage. These have no synovial cavities or joint capsule.



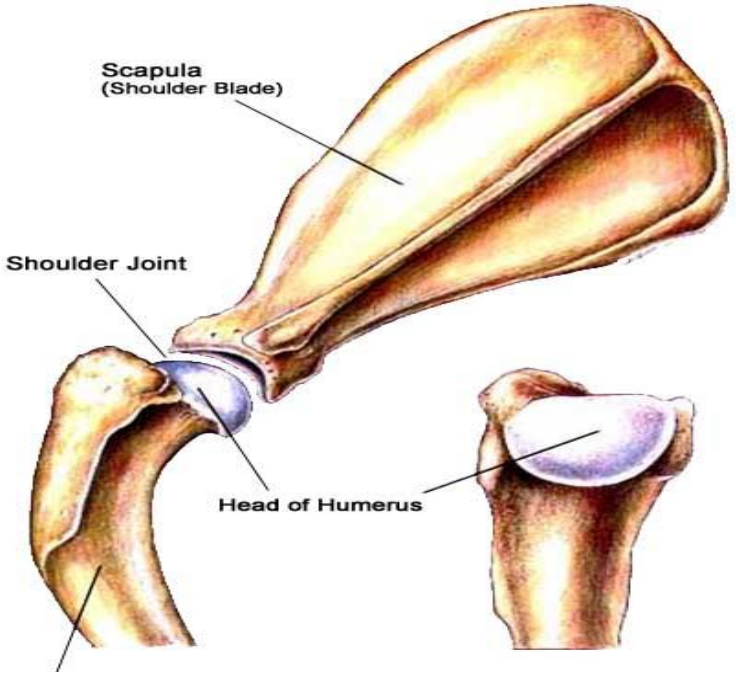
2. Joints of the Appendicular Skeleton

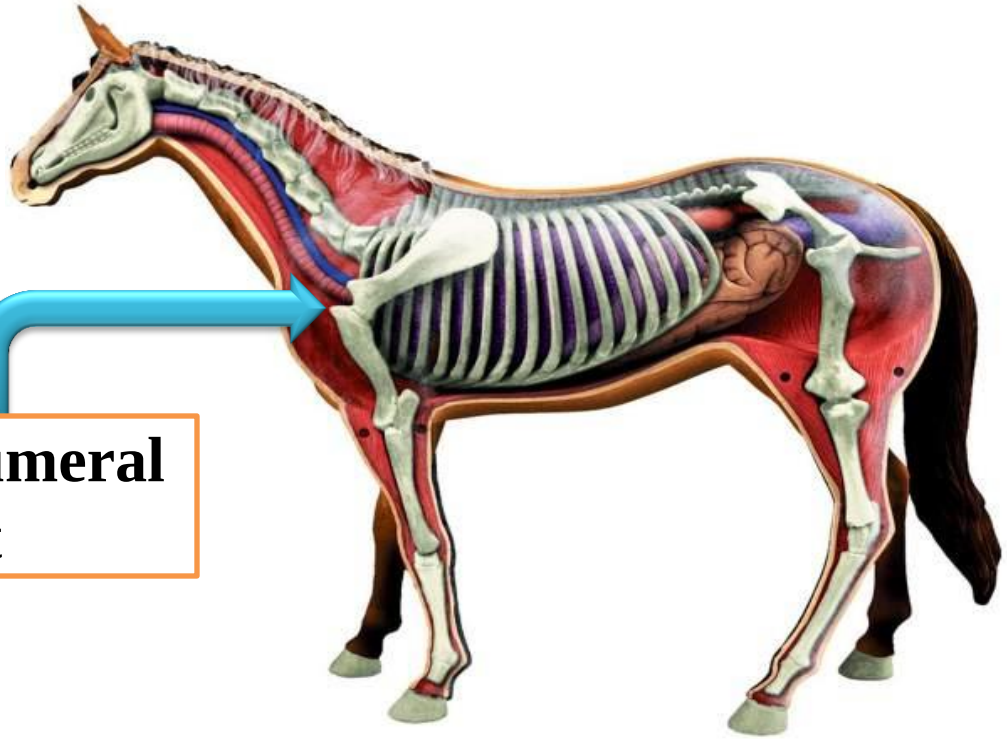
A. Joints of the Thoracic Limb

- The scapula has no true bony connection with the thorax. It is held in place by a number of muscles and ligaments. This type of joint is sometimes called a ***synsarcosis.***
- **Shoulder (scapulohumeral) joint:** is freely movable a ball-and-socket type of synovial joint.
  - ✓ The head of the humerus articulates with the glenoid cavity of the scapula.



Synsarcosis



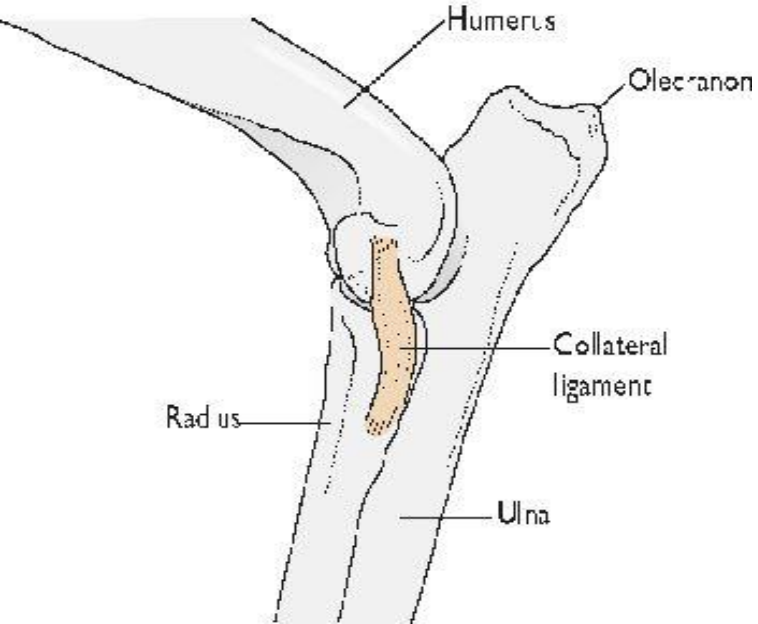


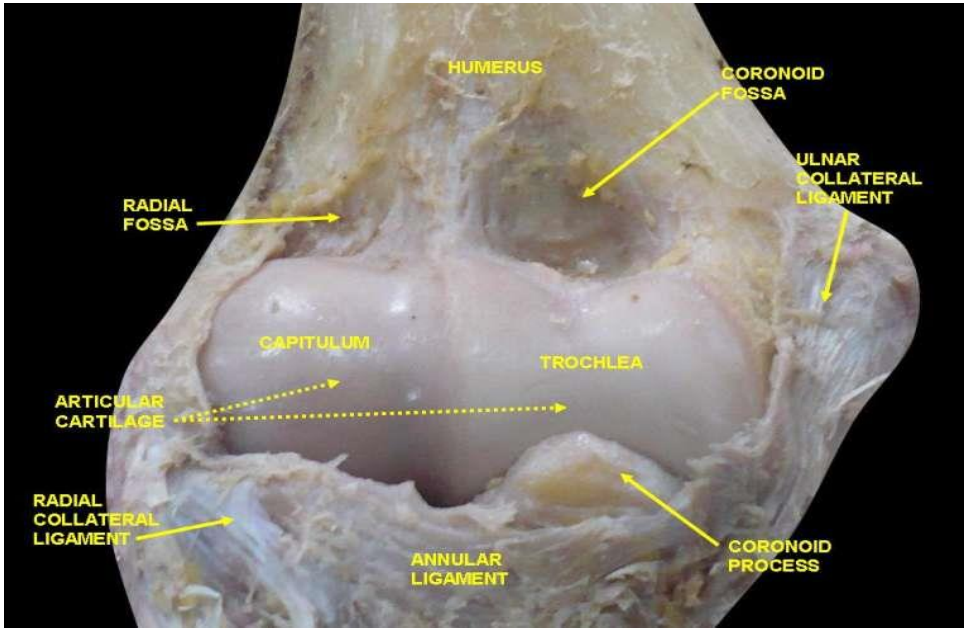
Scapulo humeral Joint

- **Elbow joint (humeroradioulnar**) articulation is a hinged type of synovial joint allowing chiefly flexion and extension movements.

- ✓ While additionally in humans and to a lesser degree in carnivores, the joint between the radius and ulna permits supination and pronation.
- ✓ It is a compound joint since it consists of three bones and there is a joint capsule encasing all three bones.
- ✓ The **humeral condyle** consisting of the capitulum and trochlea articulates with the head of the **radius**, and the anconeal process of the **ulna** fits into the olecranon fossa of the humerus.
- ✓ The medial and lateral collateral ligaments located on the sides of the joint restrict the movement to flexion and extension.

Humeroradio ulnar (Elbow) joint





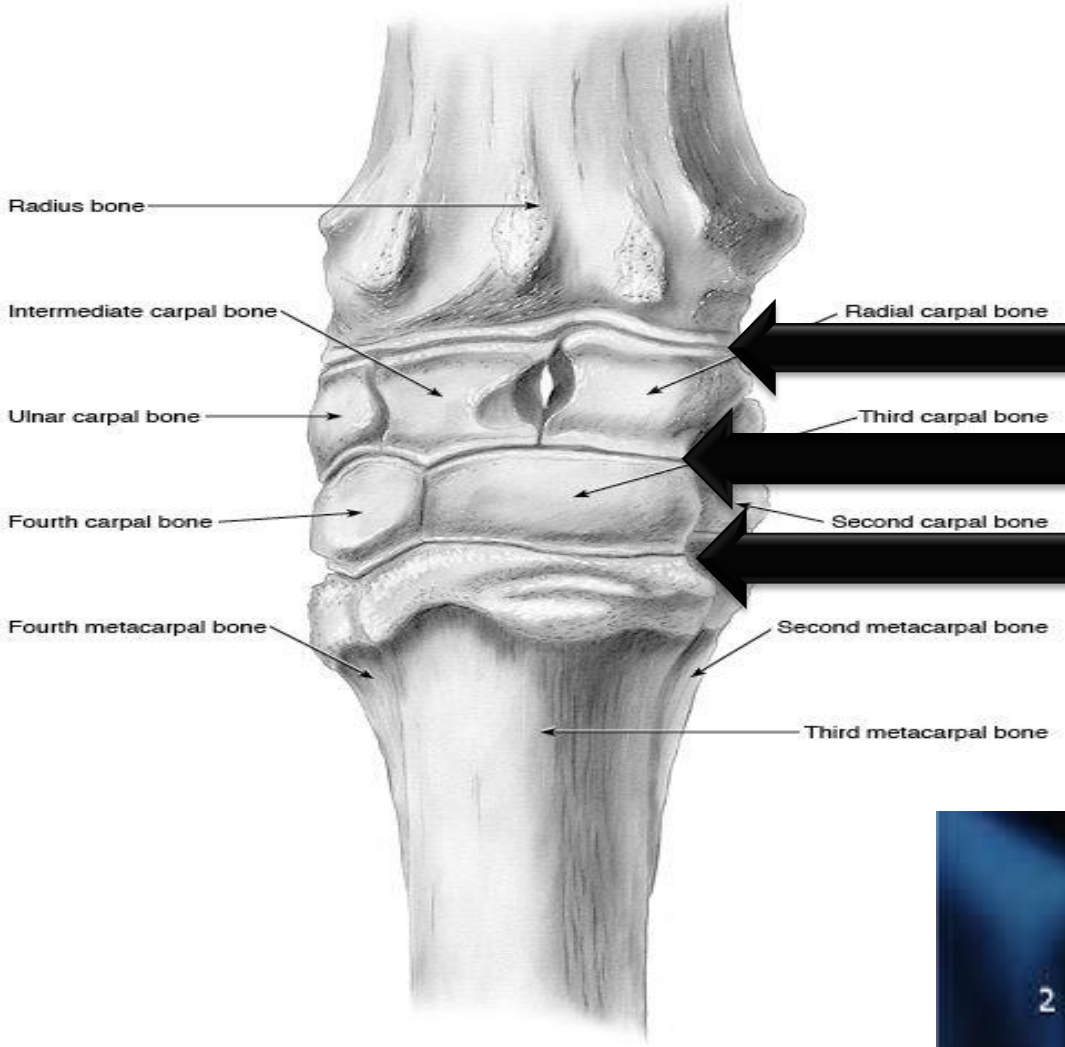
- **Carpal joint:** consists of three main joints including the antebrachiocarpal, midcarpal, and carp metacarpal joint.

✓ The carpal joint is a **hinged type** of synovial joint.

✓ The **antebrachiocarpal joint** consists of an articulation between the distal radius and ulna and the proximal row of carpal bones.

✓ The distal row of carpal bones articulate with the metacarpal bones constituting the **carpometacarpal joint**.

✓ The **midcarpal joint** is between the two rows of carpal bones.

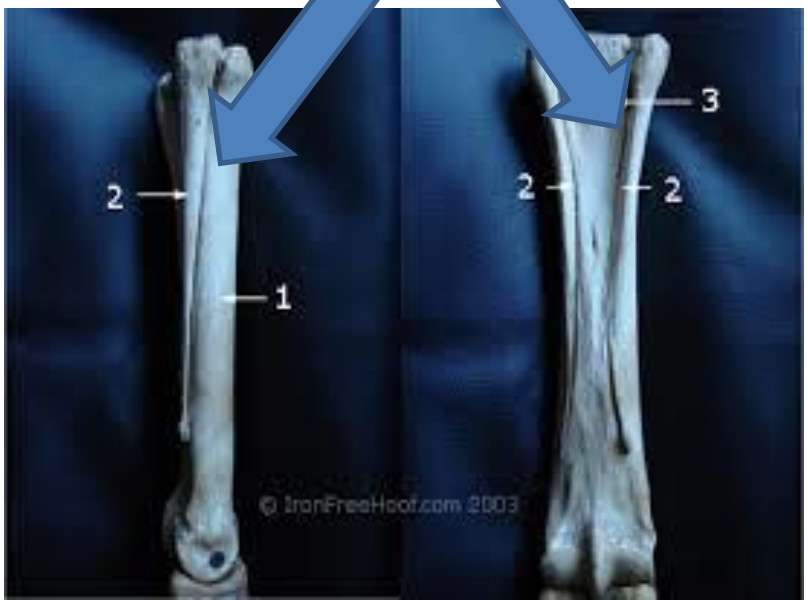


Antebrachiocarpal joint

Midcarpal joint

Carpometacarpal joint

Intermetacarpal joint (horse)



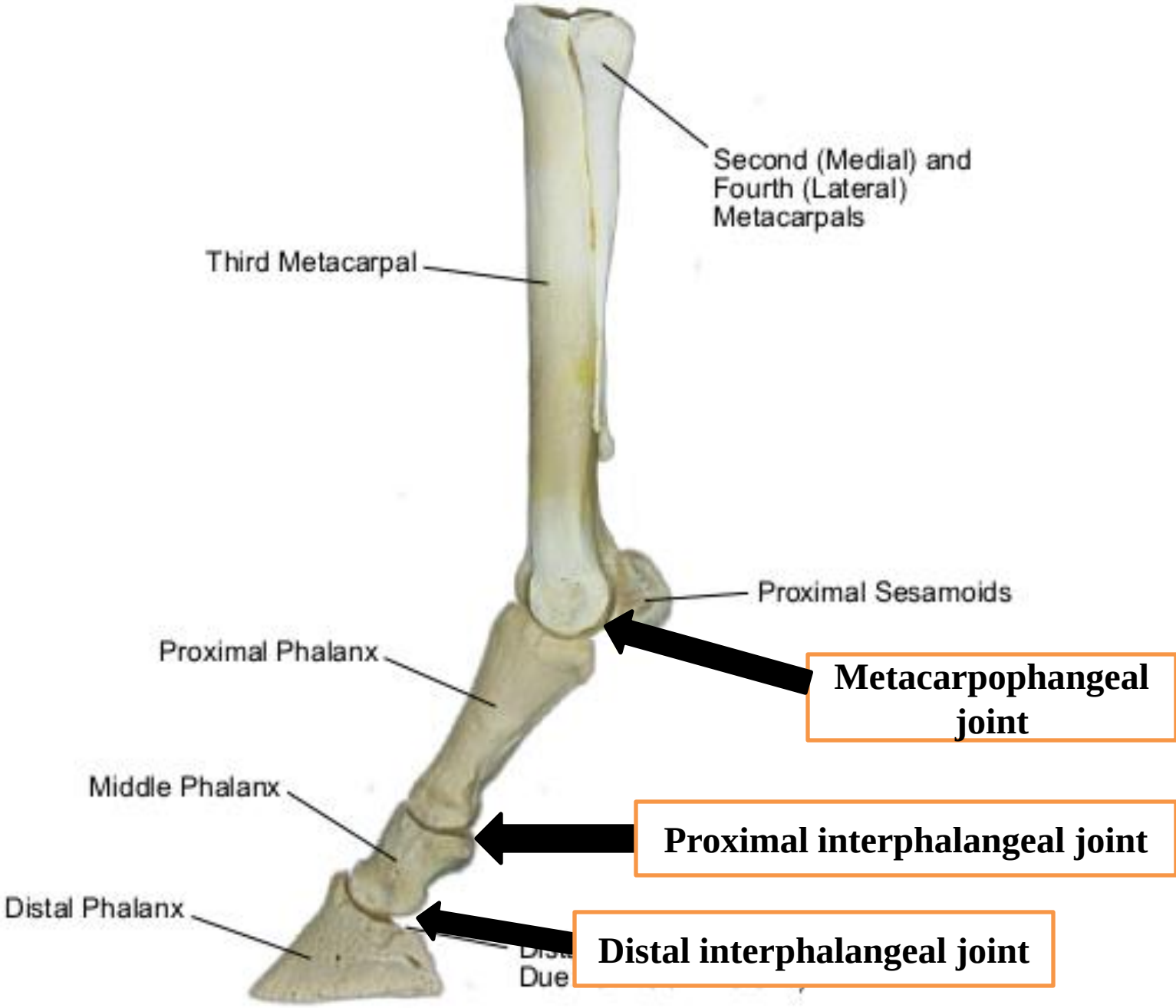
- ✓ There are plane joints between individual carpal bones.
- ✓ The carpus joint has single extensive fibrous layer of the joint capsule, but three separate synovial membrane sacs: antebrachiocarpal sac, a midcarpal sac, and a carpometacarpal sac.

In the horse, there is normally little movement between the large metacarpal III and the smaller metacarpals II and IV (splint bones) which their normal union is **syndesmosis**.

- ❑ In the ox and sheep, the third and fourth metacarpal bones are fused to form the single cannon bone, which articulates proximally with the distal carpal bones and distally with the proximal phalanges form **metacarpophalangeal joint**.

- In the dog and pig, the proximal ends of adjacent metacarpal bones abut one another in a series of **plane** joints (***intermetacarpal joints).***
- The ***metacarpophalangeal (fetlock)*** joint of the horse is formed by the distal end of the metacarpus; the proximal end of the first phalanx, or long pastern bone; and the two proximal sesamoid bones.
- ✓ It is a **ginglymus joint** that in the normal standing position is hyperextended.

- The ***proximal interphalangeal (pastern)*** joint is a **ginglymus joint** between the first and second phalanges (the long and the short pastern bones).
  - ✓ Although it is a ginglymus joint, it is rather limited in motion.
- The ***distal interphalangeal joint (coffin joint)*** is formed by the second and third phalanges and the distal sesamoid (navicular) bone.
  - ✓ The **coffin joint** is largely encased within the hoof and is essentially a **ginglymus joint**.
- A similar pattern of articulations is followed for each digit in animals possessing more than one digit per foot (e.g., ruminants, carnivores and pigs).


Second (Medial) and Fourth (Lateral) Metacarpals
Third Metacarpal
Proximal Sesamoids
Proximal Phalanx
Metacarpophangeal joint
Middle Phalanx
Proximal interphalangeal joint
Distal Phalanx
Distal interphalangeal joint
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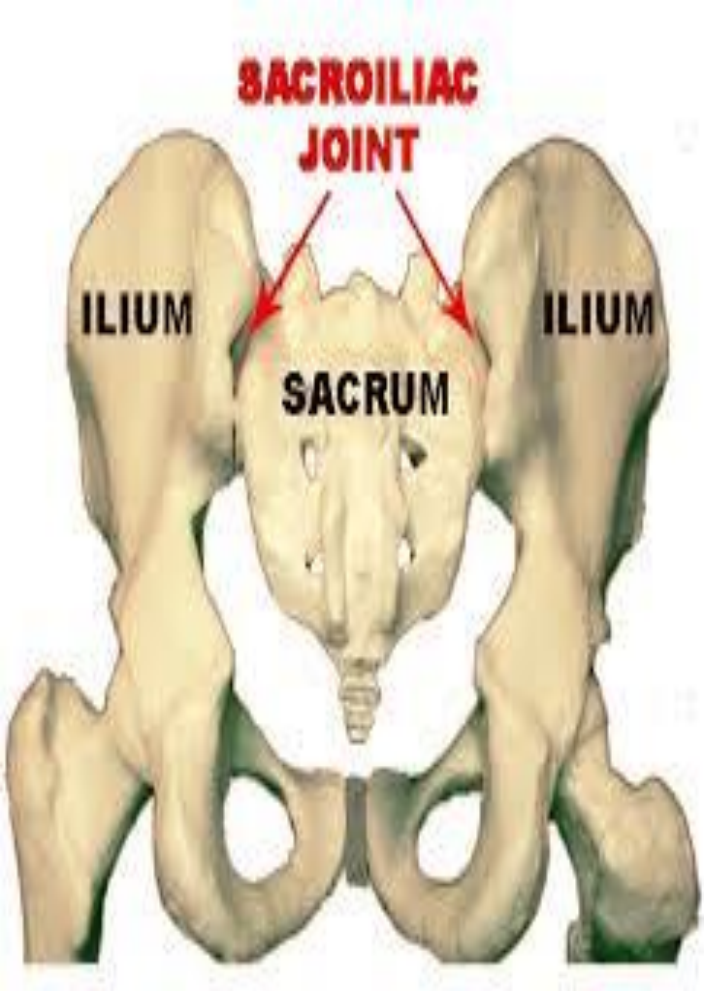
B. Joints of the Pelvic Limb

Sacroiliac joint is the only bony connection between the axial and appendicular skeletons.

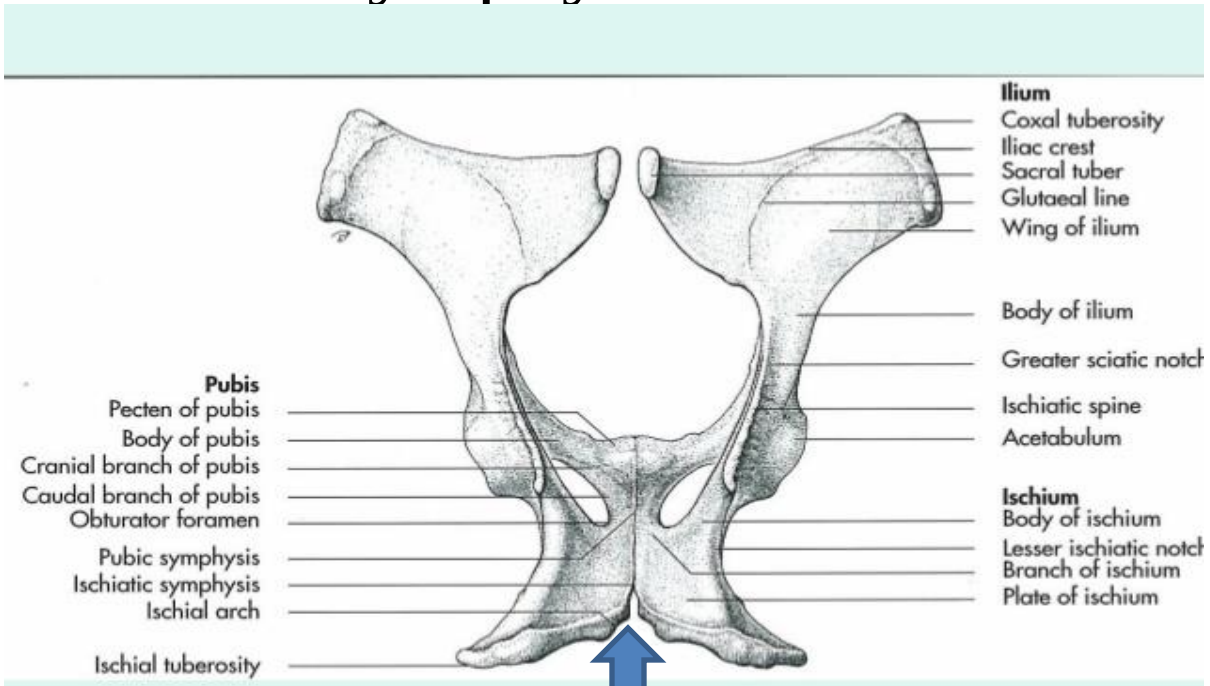
- The articular surface of the sacrum is held in tight apposition to the wing of the ilium by a number of short, strong ligaments.
- Movement in this joint is normally severely limited, but it may become more extensive just prior to parturition.



Sacroiliac joint

Pelvic symphysis is a slightly movable fibrocartilaginous joint between the hip bones (os coxae).

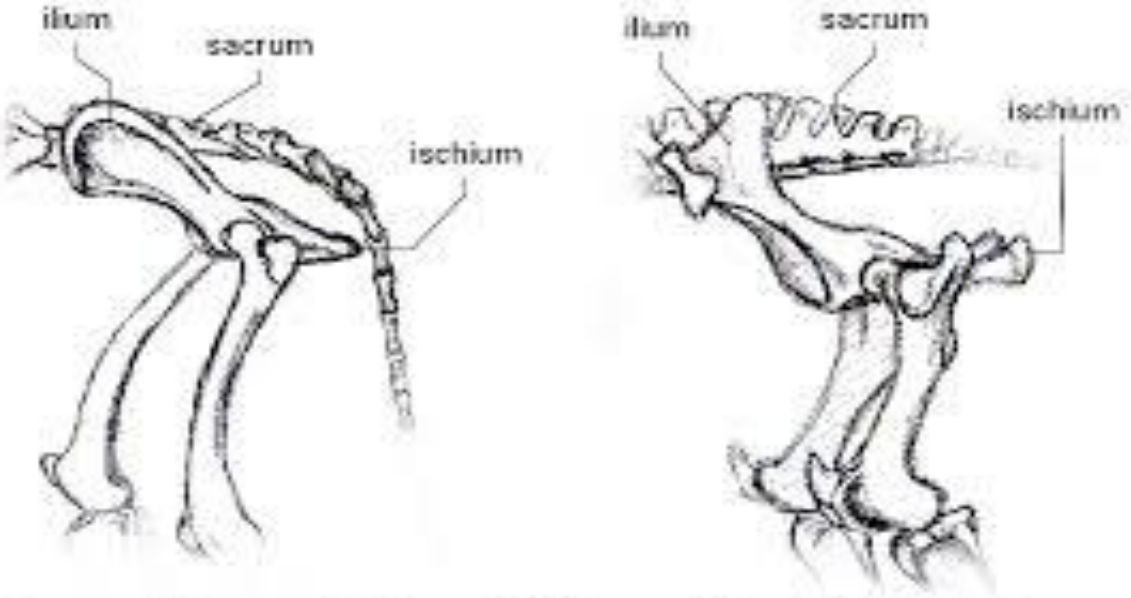
The front portion is formed by the pubic symphysis between the two pubic bones; the caudal portion is formed by the ischial symphysis between the two ischial bones.



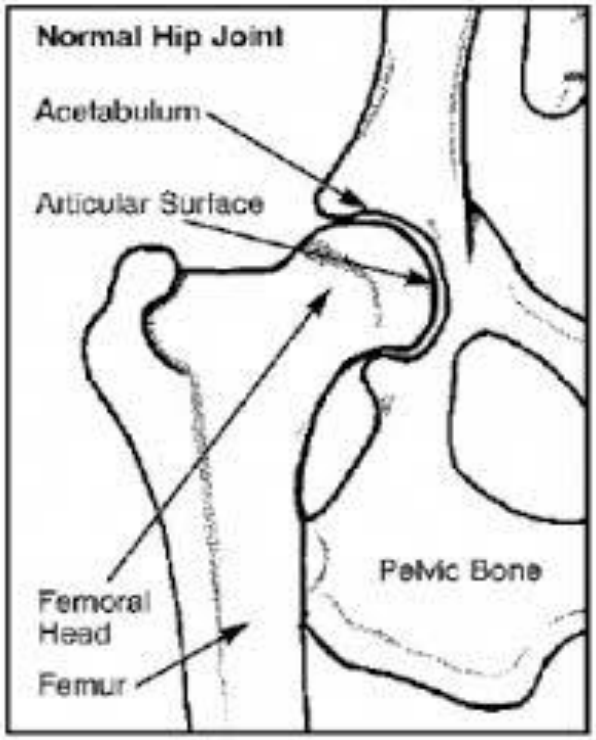
Pelvic Symphysis

Coxofemoral (hip) joint is the best example of a spheroid (**ball and socket**) joint.

- The head of the femur is about two-thirds of a sphere that fits into the less extensive acetabulum of the os coxae.
- The margin of the acetabulum is reinforced and deepened by a marginal cartilage.



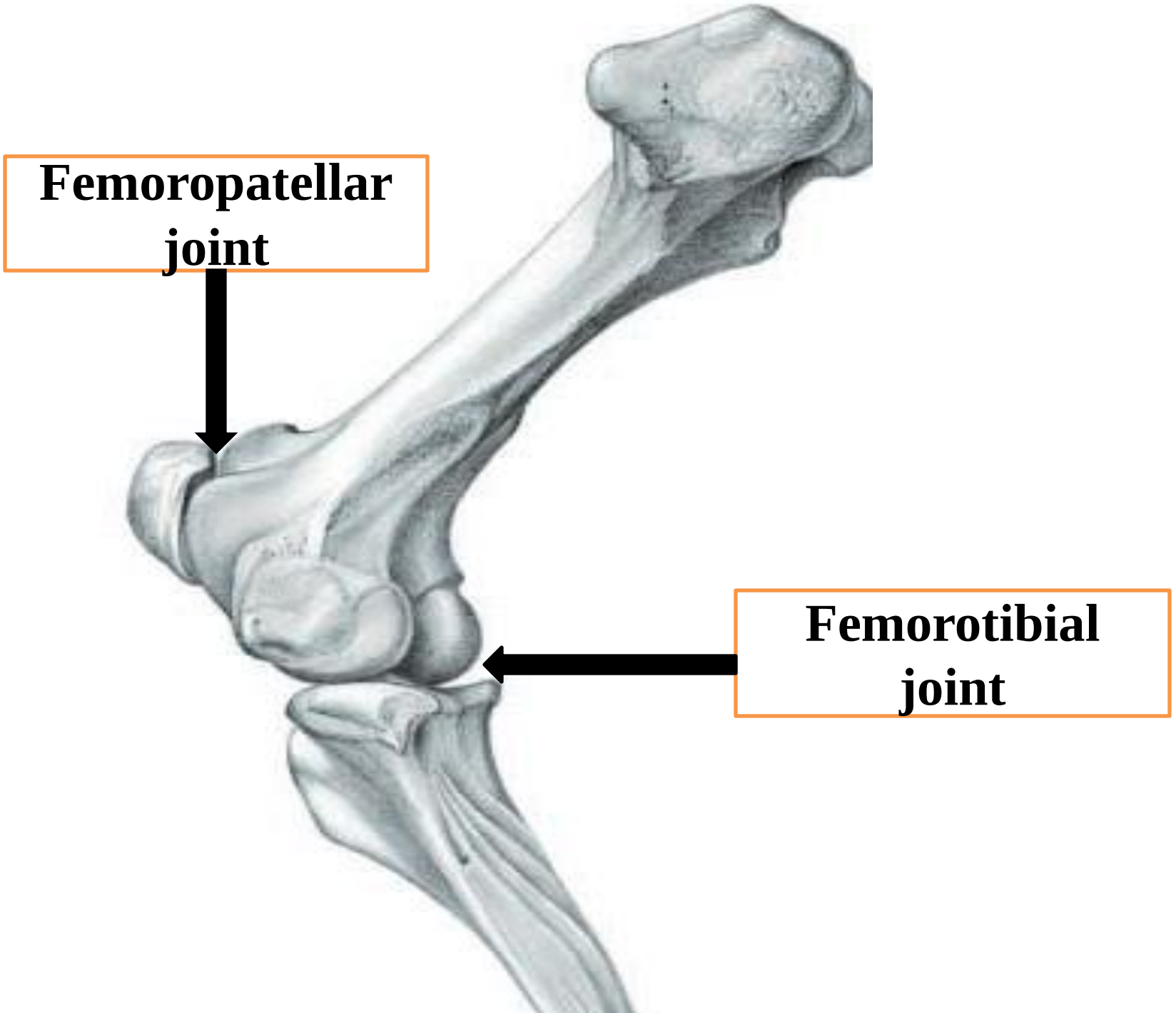
Dog and Horse Pelvis – Side View (after Ellenberger)



- It is a freely movable (diarthrodial) joint allowing universal movement (i.e., flexion, extension, abduction, adduction, lateral rotation, and circumduction).
- It has no collateral ligaments; instead, its stability depends on
  - ✓the ligament of the head of the femur,
  - ✓a strong joint capsule and
  - ✓a large muscle mass surrounding it.

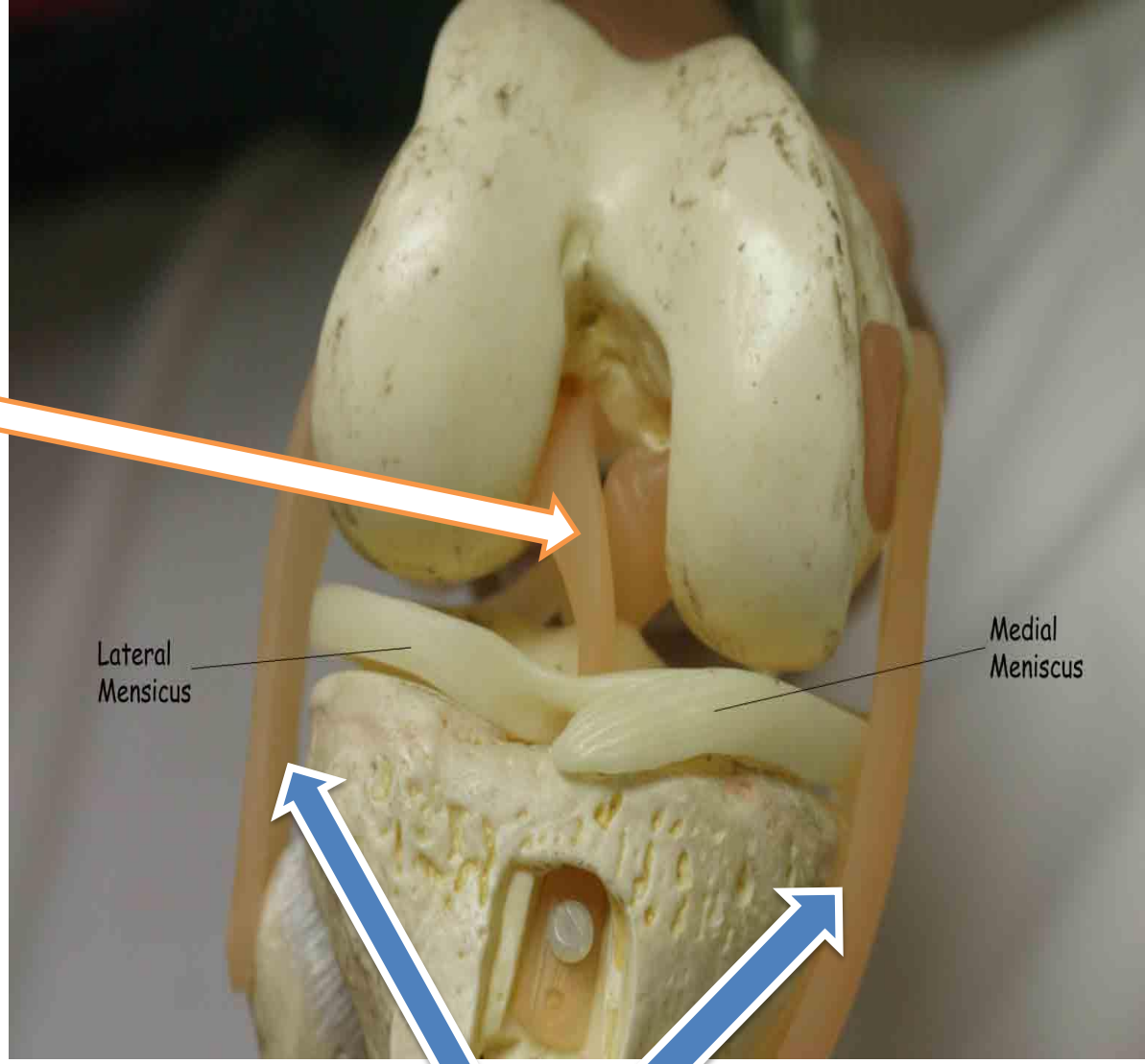
Stifle joint

- Corresponds to the human knee
- It is a **hinge type** of synovial joint allowing flexion and extension with little rotation
- It comprises of the condyles of the distal femur, the patella, and the proximal tibia.
- The joint between the patella and femur is called the **femoropatellar joint**, and contains a large joint capsule.
- The patellar ligament runs between the patella and the tibial tuberosity.
- They are three in numbers in horse and oxen, but one in carnivore, pigs and small ruminants.


Femoropatellar joint
Femorotibial joint

- The **femorotibial joint** is the articulation between the femur condyles and the tibia, and has an interposed menisci.
- The femoral condyles are separated from the proximal tibia by two intra-articular (medial and lateral) ***menisci.***
- These menisci help keep the joint congruent and absorb shock.
- The stifle is stabilized:
  - ✓by medial and lateral collateral ligaments and
  - ✓by two intra-capsular cruciate ligaments that form an X as they cross from the tibia to the femur in the middle of the joint.

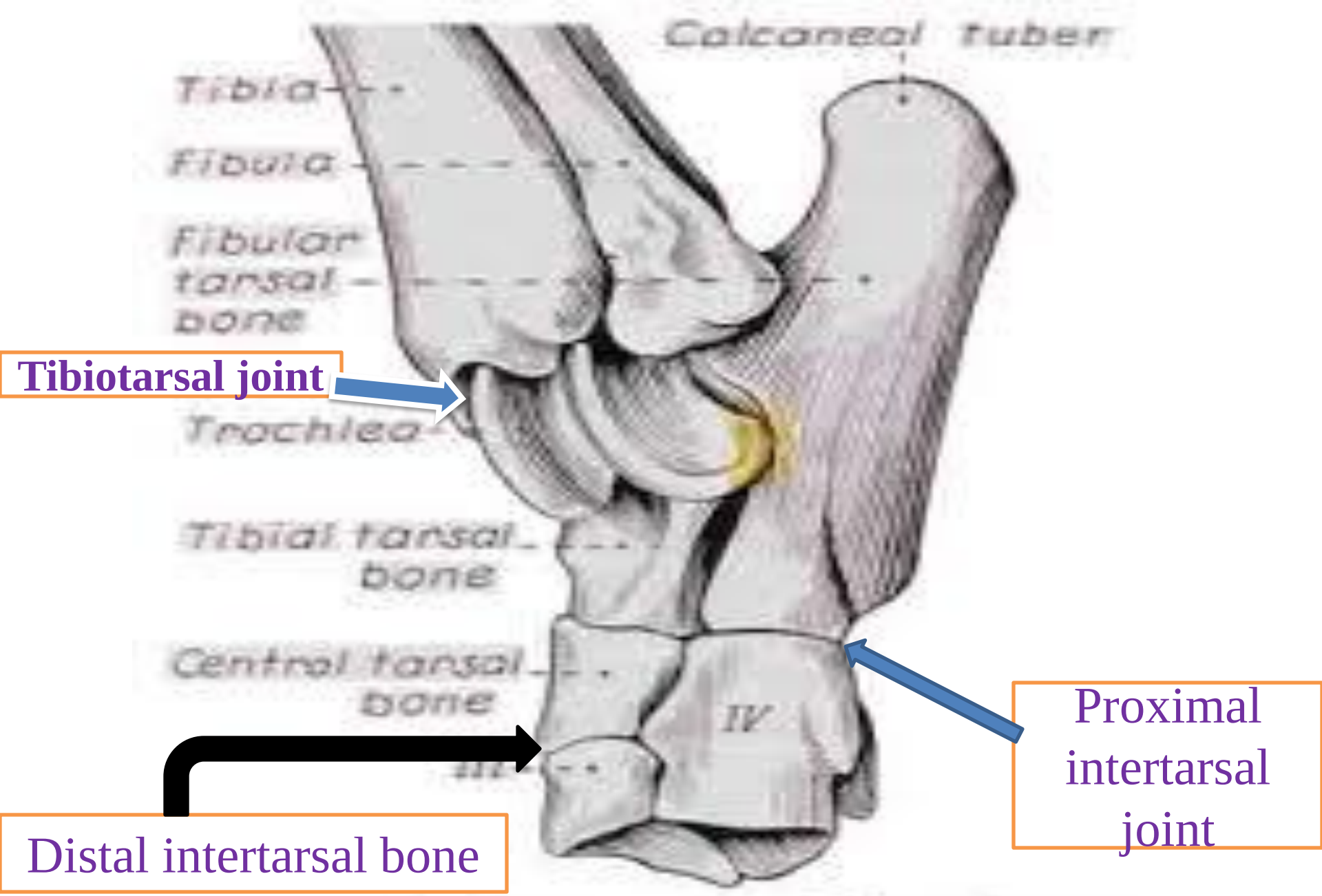
Cruciate Ligaments



Lateral and Medial collateral ligaments

Tarsal joint:

- The tarsus or hock, is a compound **hinge type** of synovial joint.
- It allows only flexion and extension.
- The **tibiotarsal portion** of the tarsus is the most movable joint, and is an articulation between the proximal row of tarsal bones (i.e., the talus and calcaneus), and the fibula and tibia.
- This portion of the joint is held together by strong medial and lateral collateral ligaments of the hock.
- The cochlea of the tibia receives the trochlear ridges of the talus.



Left tarsus, articulated, lateral aspect.

Figure 1 from Miller, et al

- The calcaneus is firmly attached to the other tarsal bones by many short, strong ligaments.
- The **proximal intertarsal joint** is the articulation between the proximal row of tarsal bones and the central and fourth tarsal bones.
- The **distal intertarsal joint** includes the articulation between the central tarsal and tarsal bones I, II, and III.
- In the horse, movement between adjacent tarsal bones is limited to a very small degree of **gliding**.
- However, in the ox, sheep, and pig, the proximal intertarsal joint has some **hinge** movement while the gliding in others.

Reading Assignment

- **Those joints distal to hock.**
- **Ossification**

Note:- Distal to the hock, the joints are look similar to those of the forelimb

Thank you!!!

Addis Ababa University
College of Veterinary Medicine And Agriculture

Gross Veterinary Anatomy I
For first year DVM students

Myology

Megarsa Bedasa (Dr.)

April, 2020

Definitions

Myology is the study of the structural and functional organization of muscles.

Muscle a specialized tissue that can undergo repeated contraction and relaxation.

- So that it is able to produce movement of body parts, maintain tension, or pump fluids within the body.

❖ In multicellular organisms:

- The muscles are the active organs of motion.
- Muscle cells possess the properties of contractility and conductivity.
- Their arrangement suggests that they may be called **fibers** instead of cells.

Importance of studying muscles

Essential to understand:

- Those structures involved during **surgical procedure.**
- Those muscles commonly considered in **meat inspection**.
- The common muscles used for **intramuscular injections**.
- The **physiology of different types of muscle** tissues in locomotion, pumping blood and other function of the visceral organs.

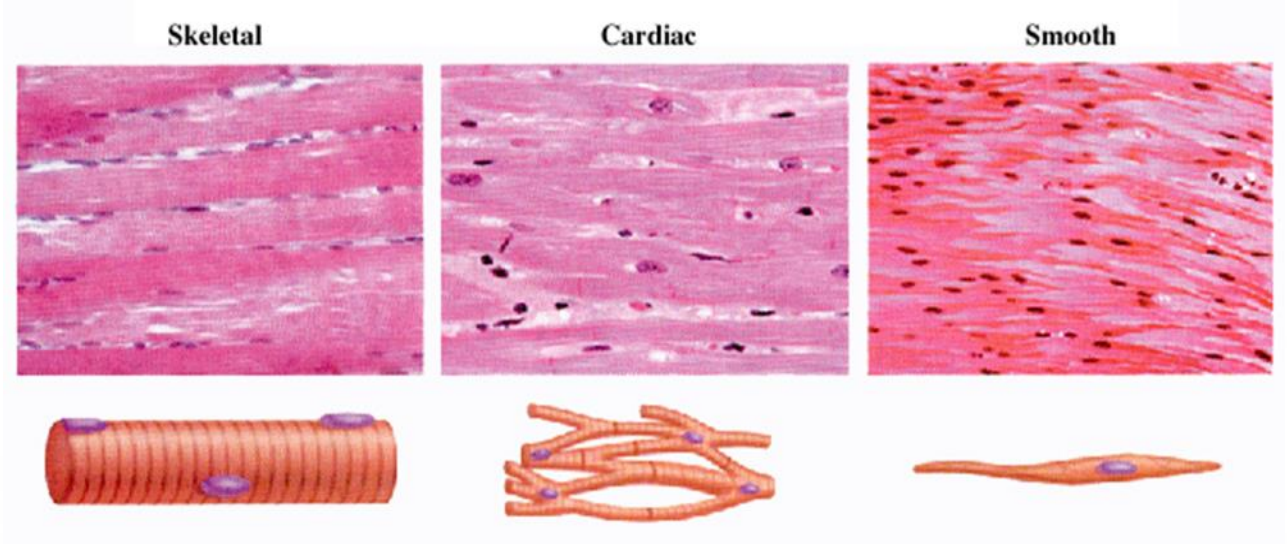
Functions of muscles

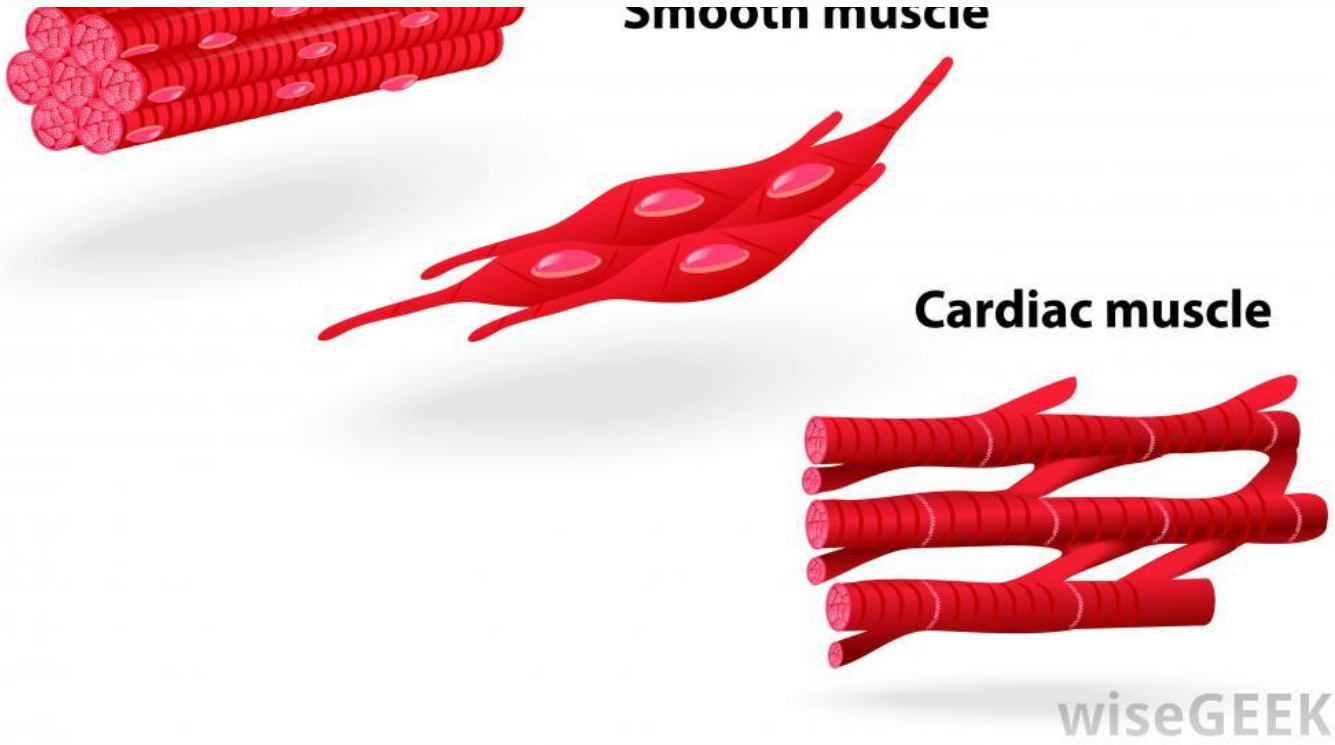
- Produce and retains movement.
- Produces heat in homoeothermic (warm blooded) animals.
- Respiration, urination and used in reproduction.
- Digestion and assimilation food.
- Ejection blood (heart) and distribution of blood in the bodies (walls of blood vessels)…etc.

- Embryologically muscles of all types originate from the **mesoderm**.

There are three types of muscle:

- Voluntary striated/striped muscle (**skeletal muscle**),
- Involuntary striated/striped, branched muscle (**cardiac or heart muscle**) and
- Involuntary non-striated/non-striped muscle (**smooth muscle**).


Skeletal
Cardiac
Smooth

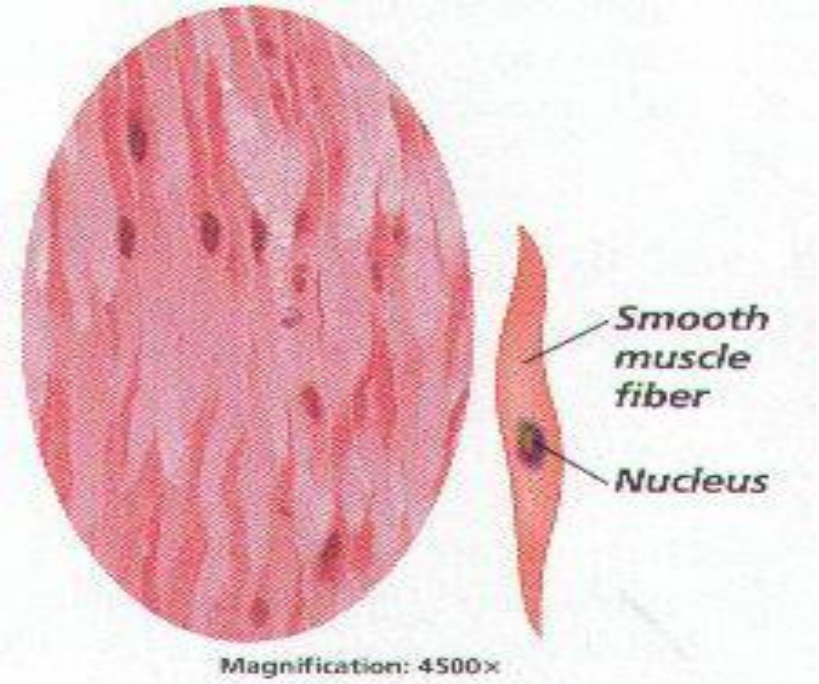

Smooth muscle
Cardiac muscle
wiseGEEK

1. Smooth Muscle

The individual muscle cells are:

- ✓ Spindle-shaped.
- ✓ Centrally located single nucleus.
- ✓ They are non striated.
- ✓ Cells are involuntary in action i.e. its contraction is controlled by motor nerve from **autonomic nervous system**.
- ✓ Cells are found in the systems, which are chiefly automatic in their function like:

- the walls of blood vessels,
- the walls of the digestive, respiratory, reproductive tract and most other viscera including glands.
- attached to hair follicles and in the iris of the eye.

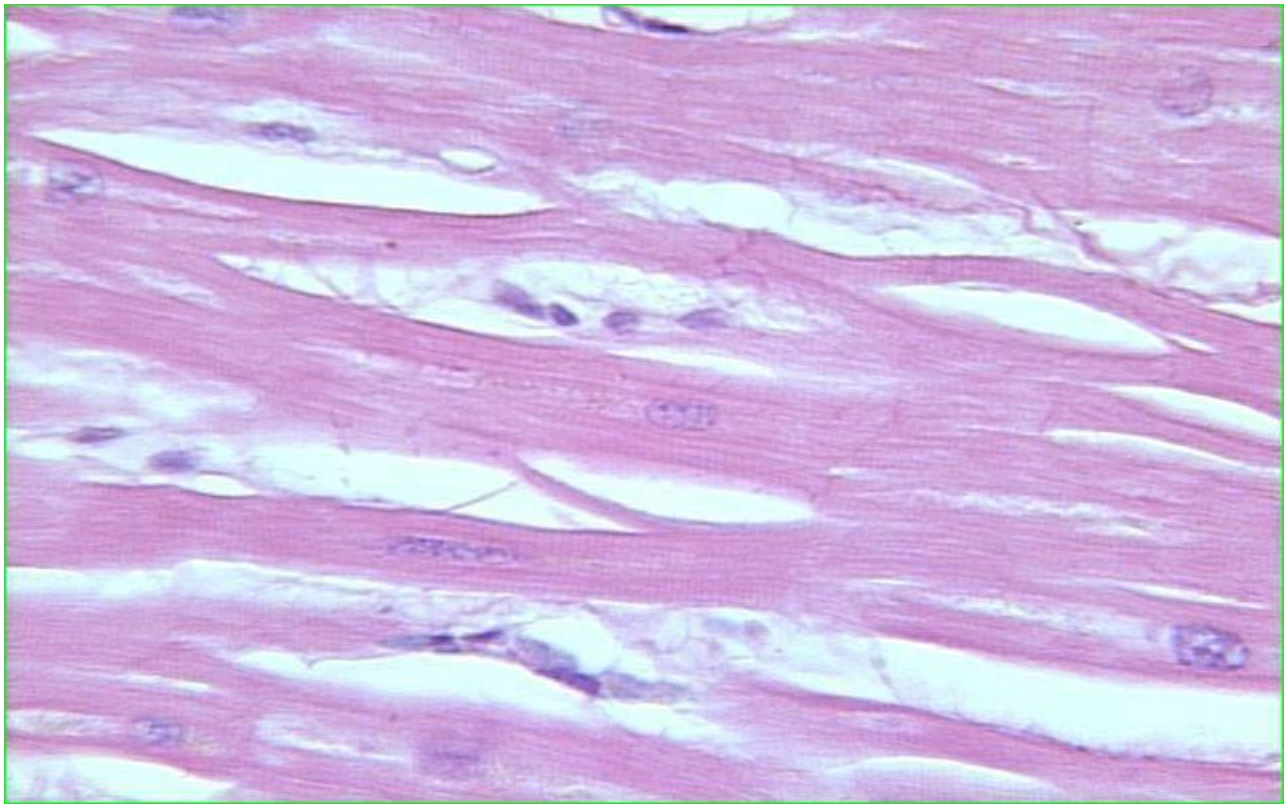


Smooth muscle fibers are under involuntary control and appear spindle-shaped.

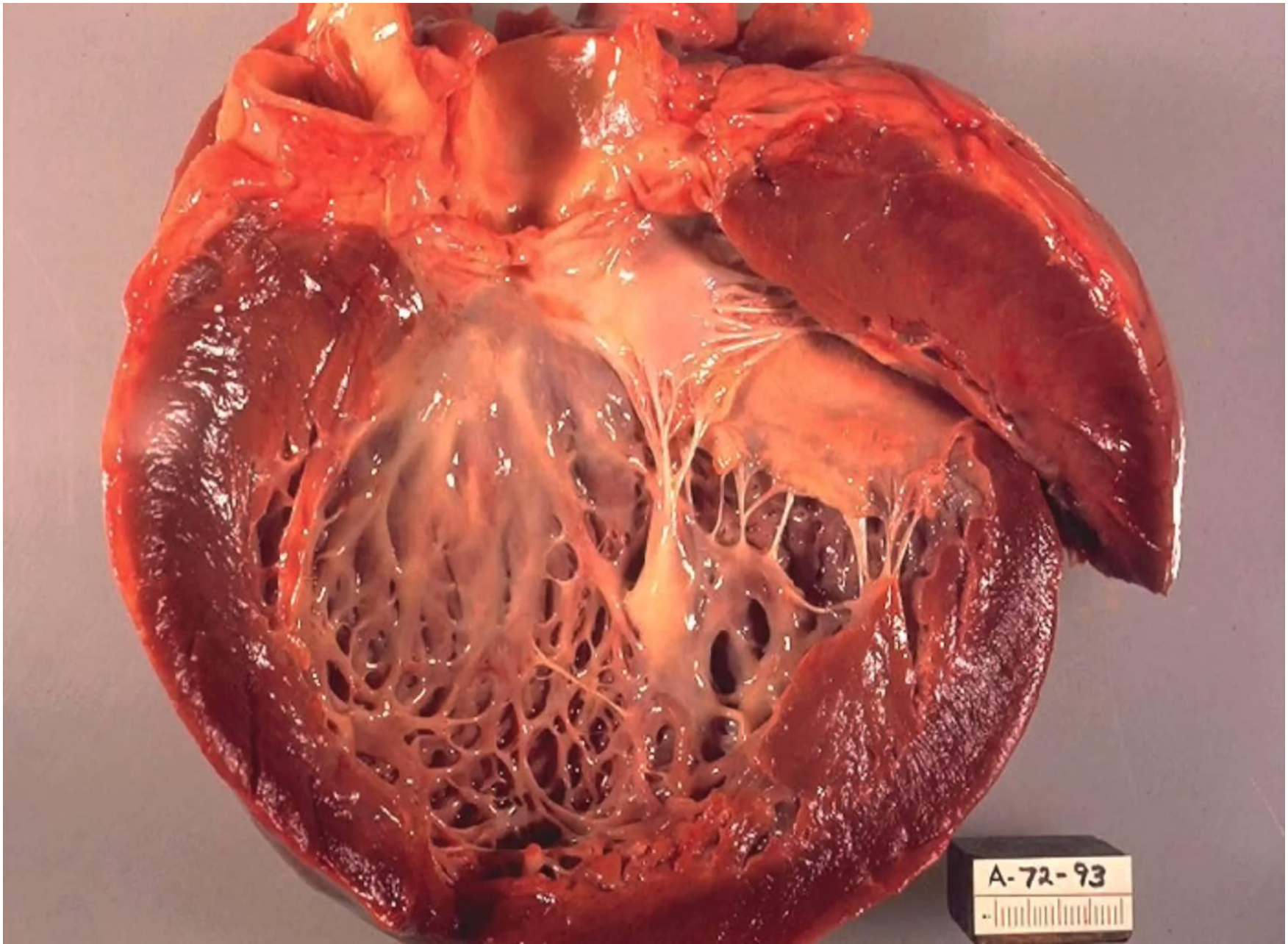
2. Cardiac muscle (myocardium)

- The cardiac muscle cells are striated arranged in the form of a network, and their nuclei are centrally located.
- Is characterized by fibers with visible striations**.**
- Has natural endogenous rhythm independent of its autonomic innervation.
- The cardiac cycle is controlled, but not initiated, by the autonomic nervous system which regulates the heart rate, force and output.
- Cardiac muscle cells are connected to each other by **gap junctions.**

- Cardiac muscle is found only in the heart where it forms the **myocardium**.
- It surrounds the four chambers of the heart including the aorta, pulmonary artery, pulmonary vein, and vena cava and is especially thick in the walls of the two ventricles .



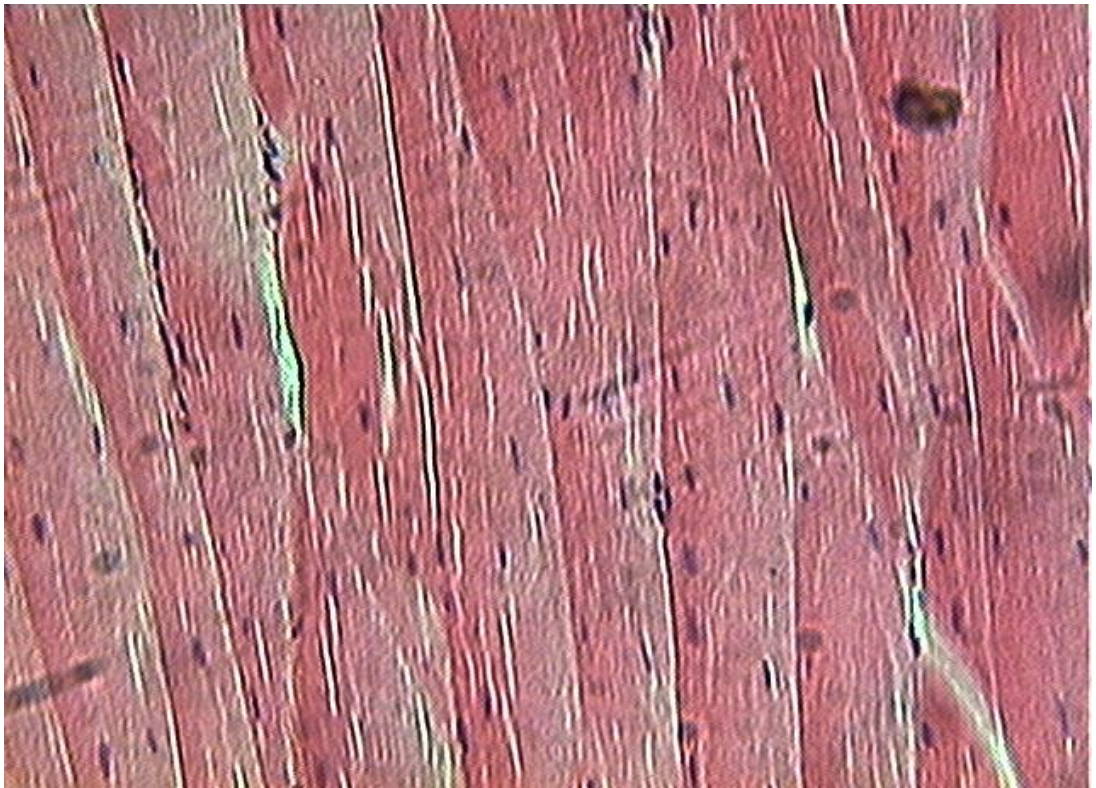
Heart muscle



3. Skeletal muscle

- The most part directly or indirectly connected with the skeleton, are often termed **skeletal or somatic**.
- The skeletal muscle cells are **striated** when viewed under the microscope.
- Each cell contains several nuclei (**multinucleated**) which are located peripherally.
- They are **voluntary** in action and each fiber is controlled directly by a branch from voluntary nerves (motor neuron) and usually under conscious control.

- The functional unit of voluntary striated muscle, called a **motor unit**, consists of a motor neuron and all the muscle fibers it innervate.
- The skeletal muscle constitutes the flesh of the animal, generally attached to bone.



Skeletal muscle

- The total force exerted by a muscle contraction is the sum of forces exerted by its individual fibers.
- Each fiber to its fullest extent, reducing its length by one third to one half.
- In order to produce skeletal movement the muscle must transverse at least one joint.

.

Only skeletal muscle will be primarily devoted to be considered in this section because it forms the bulk of the muscle mass of the body and most of the named muscles of gross anatomy.

General points on skeletal muscles

- Skeletal muscle is a **butcher's meat.**
- Accounts for about half the weight of an animal carcass.
- The proportion varies with species, breed, age, sex and method of husbandry.
- New skeletal muscles fibers are **not formed** after birth.
- Growth in muscle size is produced by enlargement of the existing fibers, which further increase in size with exercise.

- When proportion of muscles is destroyed, repair proceeds by replacement with **connective tissue**.
- Body weight may increase by deposition of **fat** within and between muscle fibers.
- Most muscles are supplied by single nerve but some may have multiple innervations.
- When the efferent nerve supply to a muscle is destroyed the muscle atrophies.
- Can the nerve regenerates?
- **Atrophy (wasting away):** the shrinking in size of some part or organ of the body, usually caused by injury, disease, or lack of use.

  *Ex .**muscle atrophy***

- Skeletal muscle are **red** in color, but the shade varying in different muscles and under various conditions.
- Active muscles are richly supplied with blood vessels so they look **red**.
- Atrophied muscles are poorly supplied with blood so they look **pale** in color.
- Skeletal muscles cover the greater part of the skeleton, and thus in a large measure determine the form of the animal.

- Muscles vary greatly in **form**, and may be classified as:

  (a) Long;

  (b) Short;

  (c) Flat;

  (d) Ring-like or orbicular.

  - ✓Long muscles are found chiefly in the limbs,
  - ✓While the flat or broad muscles occur principally in the trunk, where they assist in forming the **walls of the body cavities**.
  - ✓The ring-like or orbicular muscles circumscribe orifices which they close the body opening, and are hence termed **sphincters**.

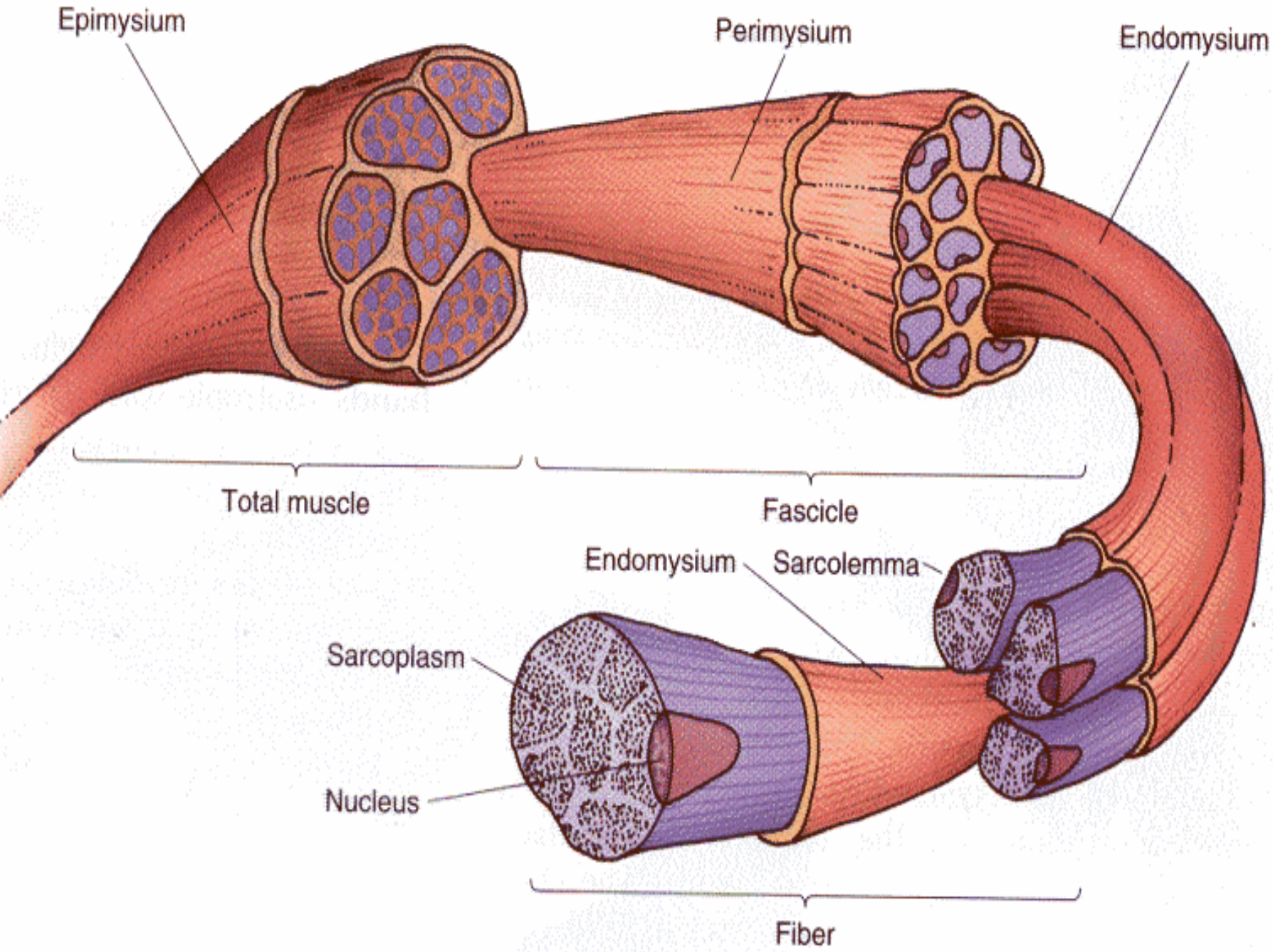
The structural arrangement and organization of skeletal muscles

This includes:

- Organization within connective tissue, wrap into different size.
- The arrangement of the tendons and direction of the muscle-fibers.

- Muscle fibers are arranged in bundles surrounded by fibrous connective tissue.

- Each muscle fiber is covered by a cell membrane known as the ***sarcolemma.***
- Around each fiber external to the sarcolemma is a film of connective tissue cover muscle fiber is called ***endomysium.***
- Each bundle of muscle fibers (*fasiculus*) is surrounded by a sheath of connective tissue called ***perimysium.***
- The connective tissue around an entire muscle is known as ***epimysium.***
- The epimysium is the **deep fascia** of the muscle.


Epimysium
Perimysium
Endomysium
Total muscle
Fascicle
Endomysium
Sarcolemma
Sarcoplasm
Nucleus
Fiber

- *The proportion of connective tissue to muscle tissue and the amount of **marbling** (fat interspersed between muscle bundle) largely account for the relative **toughness** or **tenderness** of cut meat.*

Arrangement of skeletal muscle fibers

Muscle fiber arranged as

1. Parallel
   - ✓ sheets-abdominal muscle
   - ✓ narrow bands- Sartorius muscle
2. Pennate or penniform (featherlike).

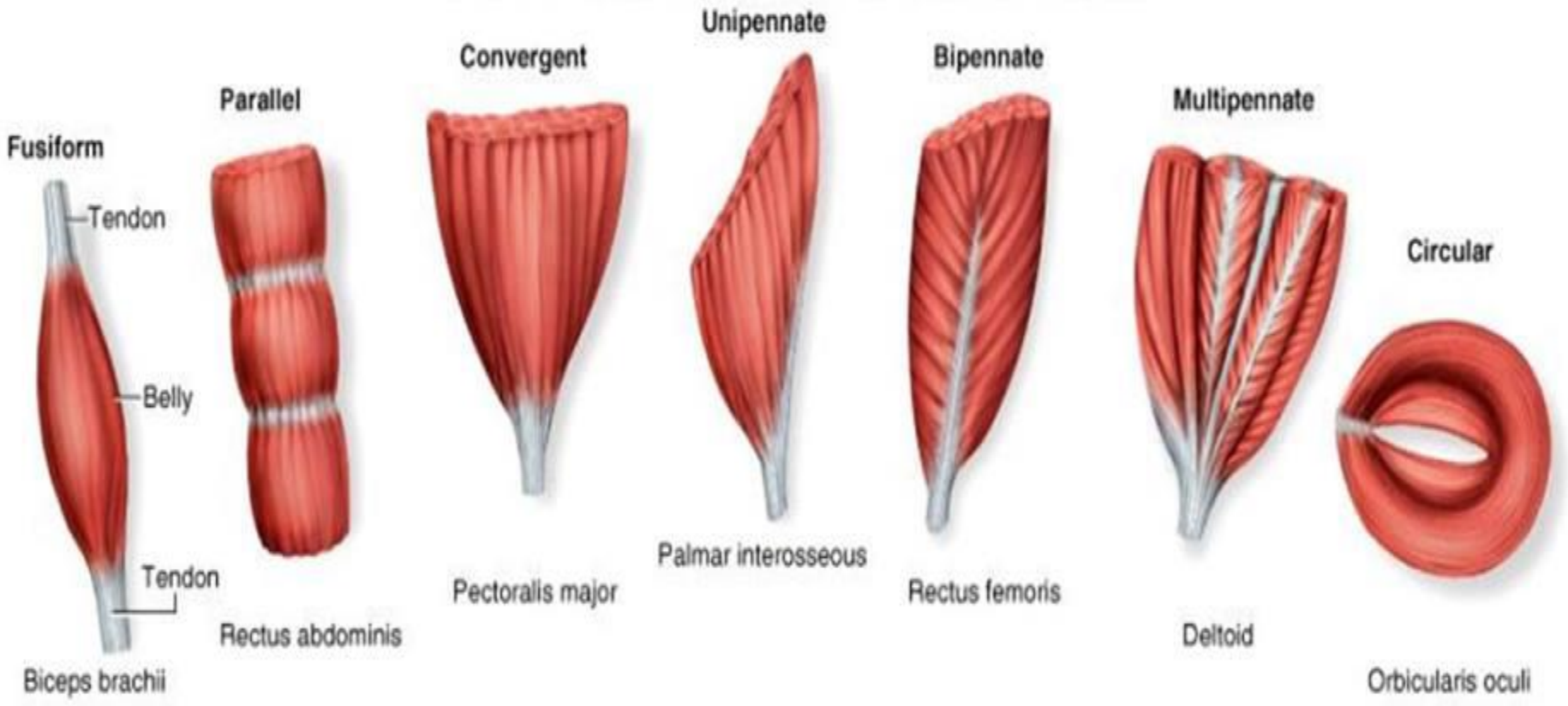
In the ***penniform*** arrangements,

- a tendon represents the quill and
- the muscle fibers attaching to the tendon at an angle represent the vane of the feather.

- The arrangement is called
  - ***unipennate***; if fibers come from only one side,
  - ***bipennate***; if fibers from two sides and,
  - ***multipennate***; if fibers from three or more sides.

3. Fusiform (spindle-shaped): in which fibers converge upon a tendon at both ends of the muscle.

Skeletal Muscle Shapes



- The parallel arrangement of muscle fibers in strap muscles provides the greatest potential for overall muscle shortening but is a relatively weak arrangement.
- While the pennate arrangement increases the power of a muscle, but at the expense of distance over which it can contract.
- The middle enlarged part of muscular tissue is often spoken of as the **belly** (Venter) of the muscle .
- In the case of the long muscles, the origin is often termed the **head** (Caput).

- Muscles having two or more heads are called biceps, triceps, etc.
- **Digastric muscles** are those which have two bellies joined by an intermediate tendon.
- Ring-like muscles which circumscribe openings are termed **sphincters**, on account of their action.

Sphincter

- A sphincter is a circular muscle that normally maintains constriction of a natural body passage or orifice.
- They relaxes as required by normal physiological functioning.
- Over 60 types sphincters are found in many animals.
- Some are microscopically small, in particular the millions of precapillary sphincters.
- They are voluntarily or involuntarily controlled:
  - ✓ Voluntary sphincters are supplied by somatic nerves.
  - ✓ Involuntary sphincters are stimulated by autonomic nerves.
- Sphincters relax at death, often releasing fluids.

EXAMPLES

- ***Sphincter pupillae***, or ***pupillary sphincter***, belonging to the iris in the eye.
- ***Orbicularis oculi muscle***, a muscle around the eye.
- The upper and lower ***oesophageal sphincters***.
  - ✓ The lower oesophageal sphincter, or cardiac sphincter, at the upper portion (cardia) of the stomach.
  - ✓ It prevents the acidic contents of the stomach from moving upward into the esophagus.
- ***Pyloric sphincter***, at the lower end of the stomach.
- ***Ileocecal sphincter*** at the junction of the small intestine (ileum) and the large intestine, which functions to limit the reflux of colonic contents back into the ileum.

- ***Sphincter of oddi***, or ***Glisson's sphincter***, controlling secretions from the liver, pancreas and gall bladder into the duodenum.
- ***Sphincter urethrae*/*urethral sphincter***, controlling the exit of urine from the body.
- ***Internal*** and ***external anal sphincter***. The inner sphincter is involuntary and the outer is voluntary. They control the exit of feces from the body.
- ***Precapillary sphincters,*** microscopic in size function to control the blood flow into each capillary in response to local metabolic activity.
- ***Preputial sphincter***, belonging to the foreskin.

It is convenient to divide the description of a muscle into **seven heads**, viz.:

1. Name, followed by important synonyms
2. Location
3. Shape (form)
4. Attachments (Origin and insertion)
5. Action
6. Relations
7. Blood and nerve supply

1. The name is determined by various factors, viz.:

a) The action, e. g., *extensor*, *adductor*, etc.;

b) The shape, e. g., *quadratus*, *triangularis*;

c) The direction, e. g., *rectus*, *obliquus*;

d) The position, e. g., *subscapularis*, *iliacus*;

e) The division (into heads, etc.), e. g., *biceps*, *triceps*, etc.;

f) The size, e. g., *major*, *minor*, etc.;

g) The attachments, e. g., *sterno-cephalicus*, *mastoido-humeralis*;

h) The structure, e. g., *semitendinosus*.

- In most cases two or more of these factors have combined to produce the name,

e. g., *biceps femoris*, *obliqius externus abdominalis*, *adductor magnus*.

- The **Latin names** are usually highly descriptive of the function and/or appearance of the muscle.
- In Latin, the noun is written first, followed by adjectives that describe it.
- For example, the *musculus triceps brachii* (literally, the three headed muscle of the arm) begins with the noun *musculus*, *usually abbreviated as m.*, plural *mm*.

2. Location: describing scope of extension of muscles.

3. The shape is in many cases, sufficiently definite to allow the use of such terms as triangular, quadrilateral, fan-shaped, long, flat, fusiform, ring like, etc.

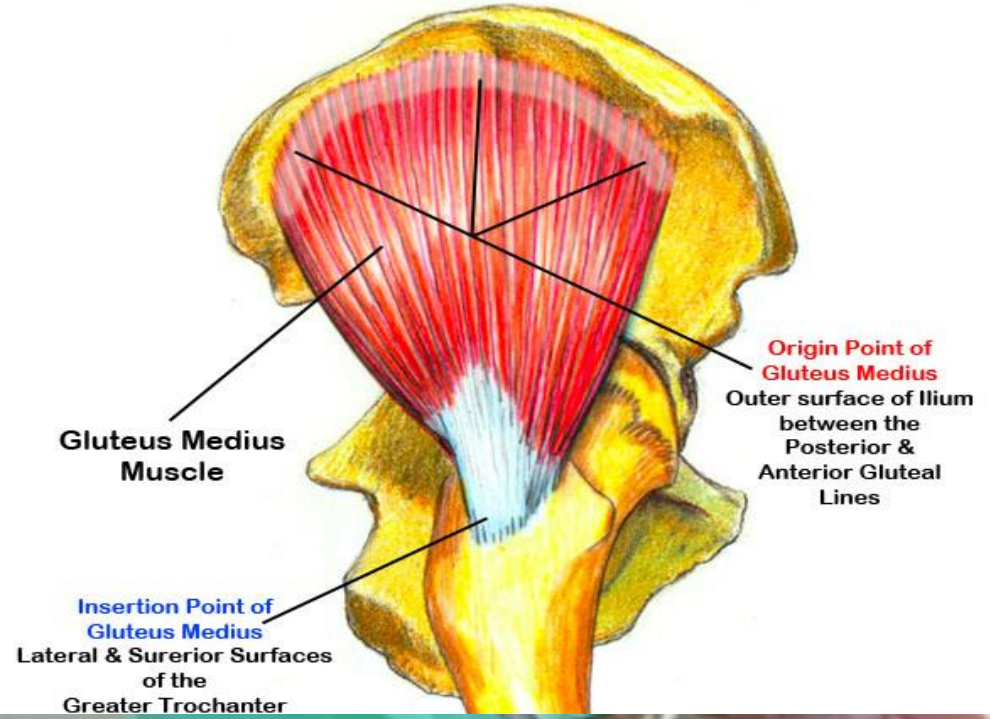
4. Attachments

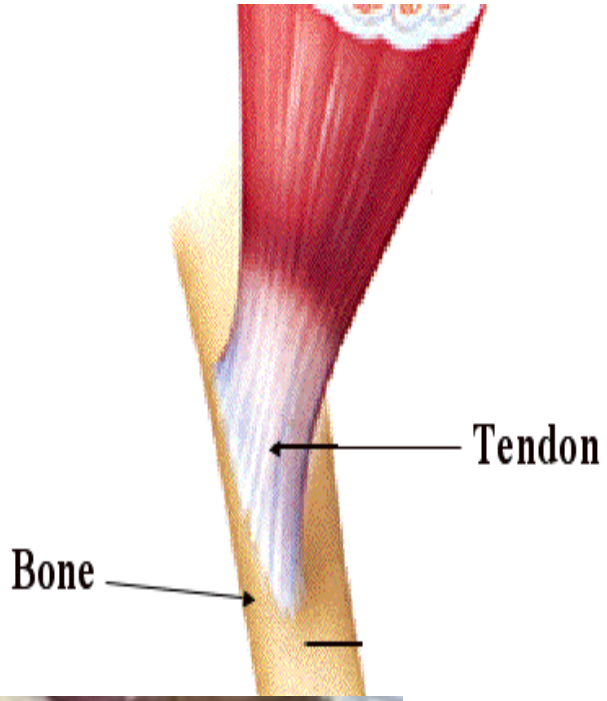
- The muscles are attached to bones, cartilages, ligaments, fasciae, or the skin.
- In all cases the attachment is by means of **fibrous tissue**, the muscle fibers not coming into direct relation with the bone or cartilage.

- The epimysium of the muscle may fuse directly with the periosteum or perichondrium (**fleshy attachment**), or
- The union may be by means of intermediary fibrous structures called **tendinous attachment** (**tendon bands or aponeuroses**).

Tendons are fibrous bands of collagen connecting muscles to bone.

- Its composed of dense, regular connective tissue in parallel bundles.
- Most tendons are **cords or bands** that attach spindle-shaped or pennate muscles to bones.
- Other tendons are **flat sheets** known as ***aponeuroses*** (singular, ***aponeurosis)***, usually associated with flat muscles.


Gluteus Medius Muscle
Origin Point of Gluteus Medius
Outer surface of Ilium between the Posterior & Anterior Gluteal Lines
Insertion Point of Gluteus Medius
Lateral & Surerior Surfaces of the Greater Trochanter


Tendon
Bone

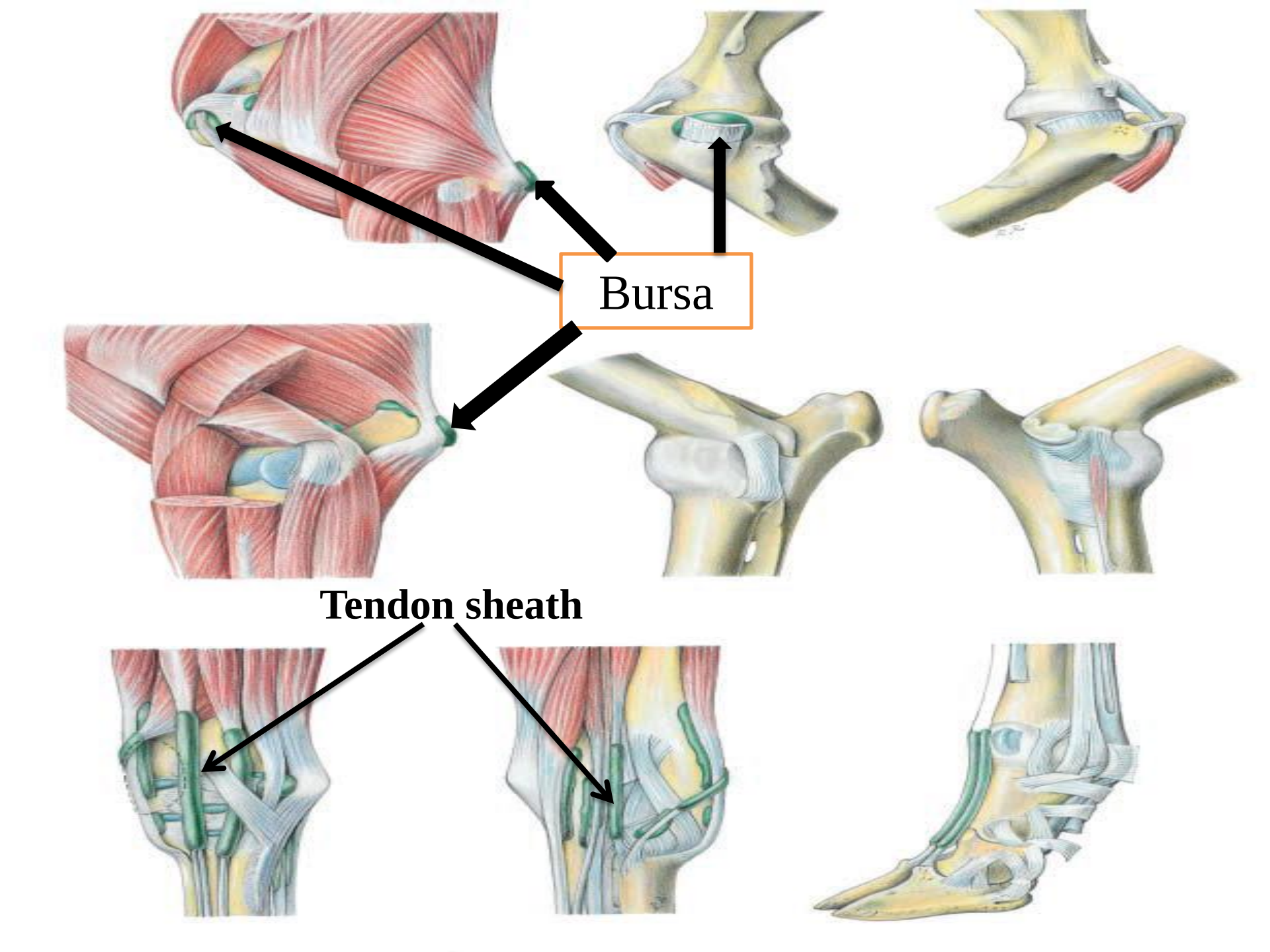
- It is usual to apply the term:
  - ✓ **Origin** to the attachment which always or more commonly less movable and produce less action when the muscle contracts.
  - ✓ **Insertion** to designates the movable attachment which produce significant action.
- Such a distinction cannot always be made, as both attachments may be freely movable.

5. **The action** belongs rather to physiological study, but is briefly indicated in anatomical descriptions in the next subtopic as '*functional classification of muscle*' like adductor, abductor, flexor, extensor muscle, ...etc.
6. **The relations** are, of course, important on surgical grounds.
7. **The nerve and blood supply** is of clinical interest, & is important for the determination of homologies.

❖There are also accessory structures which are connected with the muscles: **the synovial membranes and the fasciae.**

1. **The synovial membranes** are arranged in two principal forms: **bursa** and **tendon sheath** (*vaginal tendinis*).

- **A bursa** (*bursa mucosa*) is a simple sac interposed between the tendon or muscle and some deeper seated structure most commonly a bony prominence.
- In certain situations bursae occur between the fascia and underlying structures (sub fascial bursae), or between the fascia and the skin (subcutaneous bursa).
- **A tendon sheath** differs from a bursa in the fact that the synovial sac is folded around the tendon more or less completely.
- The two layers are continuous along a fold and termed **mesotendon**.


Bursa
Tendon sheath

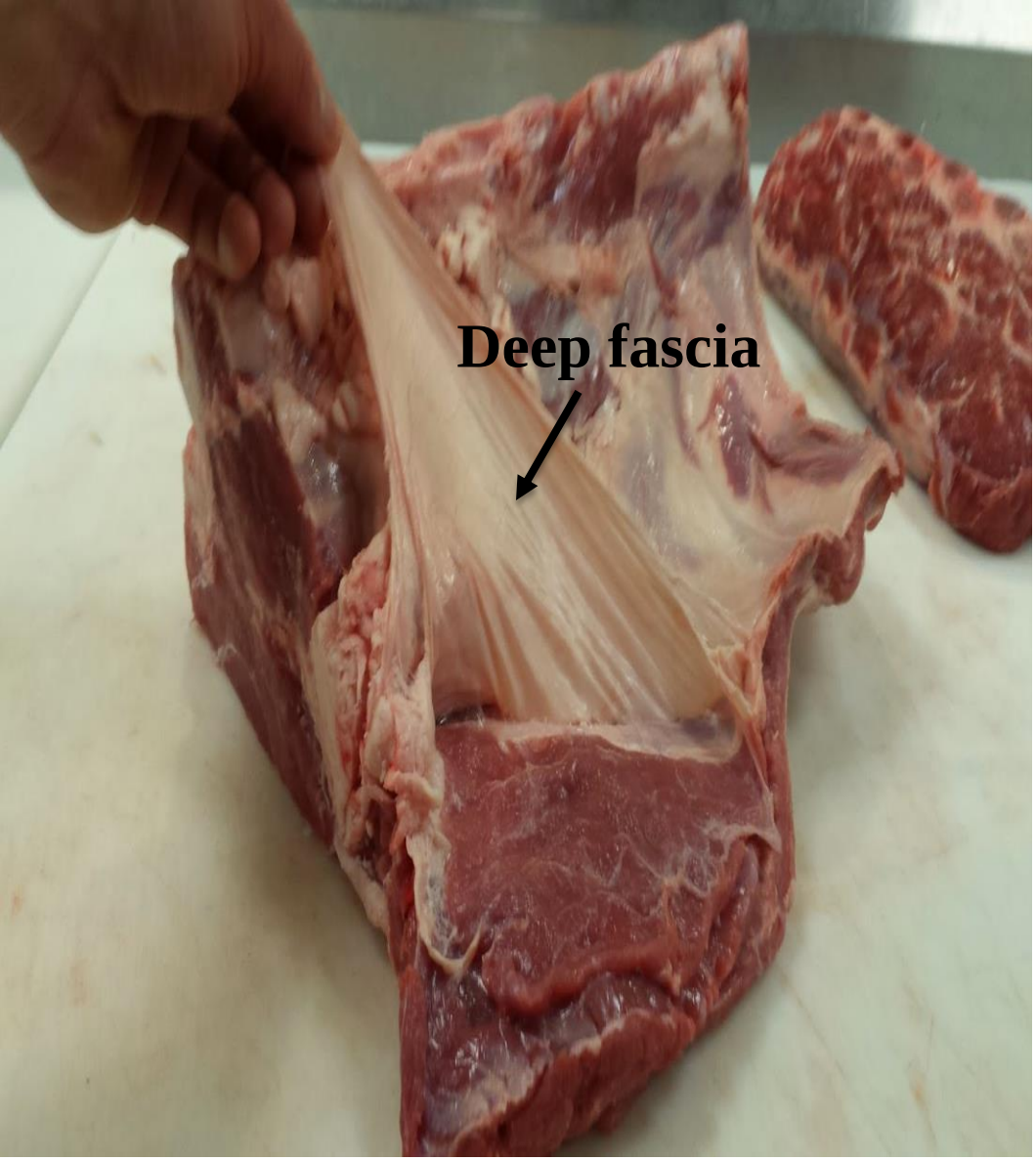
2. The fasciae are sheets of connective tissue, mainly of the white fibrous variety, with a greater or less admixture of elastic fibers in certain cases.

- It separates muscles from each other and binding them into position.
- Two layers may usually be recognized.

a. Superficial fascia is composed of loose connective tissue which may contain more or less fat and is found in subcutaneous (found next to the skin).

b. Deep fascia is composed of one or more layers of dense fibrous tissue spread over the surface of the muscles.

It investing the group of muscles (group of fasiculus) and sending intermuscular septa.


Deep fascia


Superficial fascia

Functional grouping of muscles

- **Flexor:**

  If the muscle is located on the side of the limb toward which the joint bend in decreasing the angle b/n the segments; it will be a flexor of that joint.

  Ex. *biceps brachii* is flexor of the elbow joint.

- **Extensor:**

  If the muscle is located on the opposite side of flexor.

  Ex. *triceps brachii* is extensor of elbow joint.

- **Adductor-** muscles which tend to pull limb towards a median plane.
- **Abductor-** those muscles that tend to move the limb away from the median plane.
- **Sphincter-**muscles, which surround an opening, and can open and close it.
- They are whether striated or smooth muscles.

Ex. *pyloric sphincter* is smooth muscle, while *Orbucularis oculi* muscle of the eyelid is skeletal muscle.

- **Agonists** (prime mover)**:**

➢ These are muscle directly responsible for producing the desired action.

- **Antagonists:**

➢ These are the muscles that oppose the desired action. They are opposite to agonists.

- **Synergists:**

➢ These are muscles that oppose any undesired action of the agonist.

➢ For example, *triceps brachii* is extensor of elbow joint (**agonist**, the desired action), *biceps brachii & brachial m.* are **antagonist** because they produce opposite action, flexor of the elbow joint.

- Since the long head of the triceps can flex the shoulder joint as well as extend the elbow, any muscle that opposes flexion of the shoulder joint is a synergist of elbow flexion.
- S*upraspinatus* and *brachiocephalic* muscles are synergistic for this particular action.
- Whether a given muscle will be classified as an agonist, an antagonist or as a synergist depends entirely on the specific action being considered.

- In describing skeletal muscles the following point are generally considered:
  - Name
  - Location
  - Origin
  - Insertion
  - Action
  - Structure (shape)
  - Relationships

Regional classification of muscle

1. Cutaneous muscle

- Is a thin muscular layer are developed in the superficial fascia between the skin & deep fascia covering the skeletal muscles.
- Intimately adherent in a greater part to the skin,
- Has very little attachment to the skeleton.
- They are responsible for the movement of the skin, so dislodge the fly when it rests on skin of many animals.
- Is conveniently divided into
  - ✓ facial,
  - ✓ cervical,
  - ✓ omobrachial and
  - ✓ abdominal parts.

Facial parts (***m. cutaneous faciei et labiorum***)

- It extends over the mandibular space and the masseter muscle.

Cervical part (***m. cutaneous colli***)

- It is situated along the ventral region of the neck.
- The *m. cutaneous faciei* and *m. cutaneous colli* together comprise the well-developed **platysma** in pig and man.

Omobrachial part (*m. cutaneous omobrachialis*)

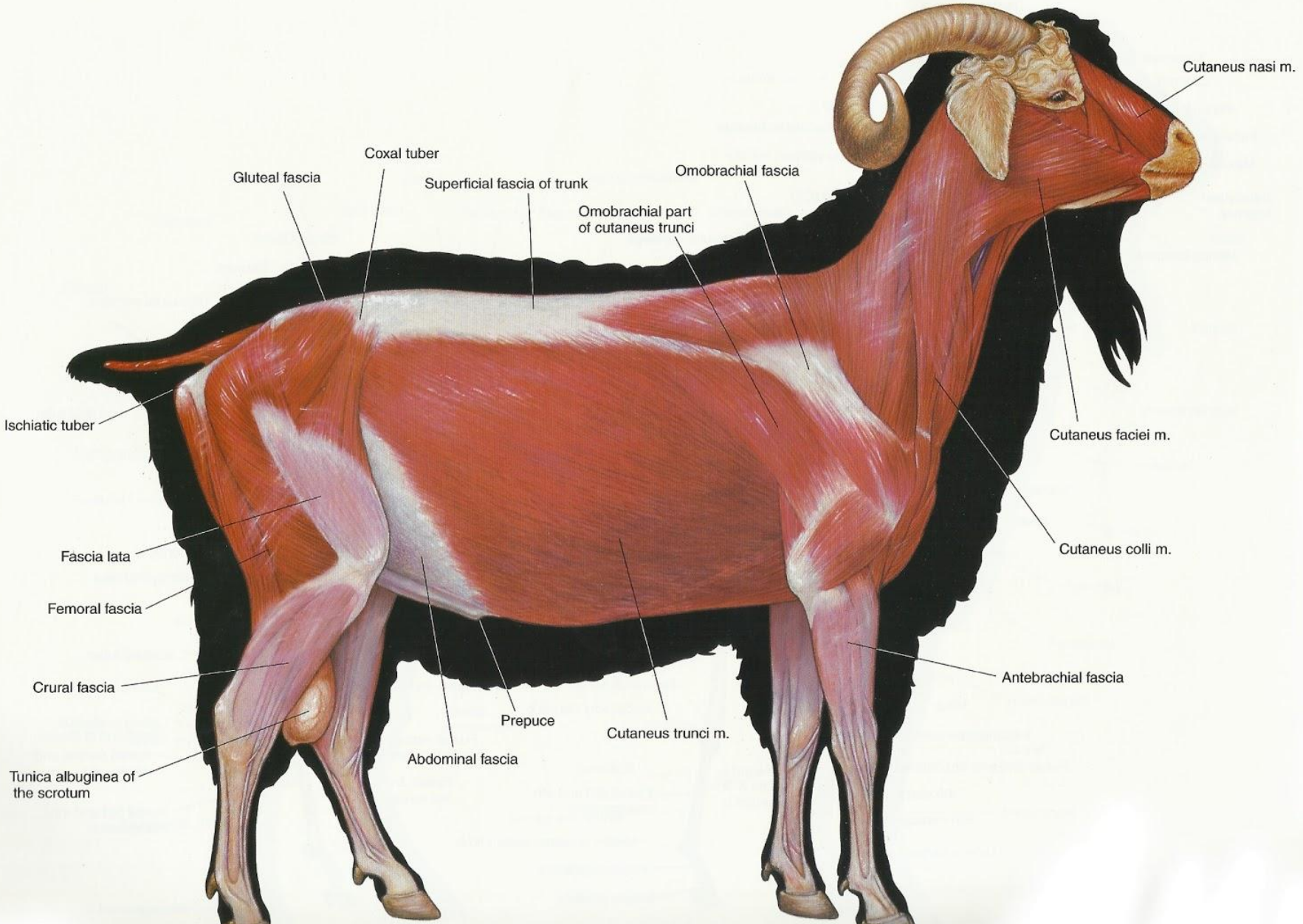
- It covers the lateral surfaces of the shoulder and the arm.

Abdominal part *(m. cutaneous trunci*)

- It covers a large parts of the body caudal to the shoulder and arm.
- Cranially, it is partly continuous with *omobrachialis*.
- *Cutaneous trunci* is in general closely adhering to the skin;
- Its voluntary contraction twitches the skin thus getting rid of insects or other irritants.

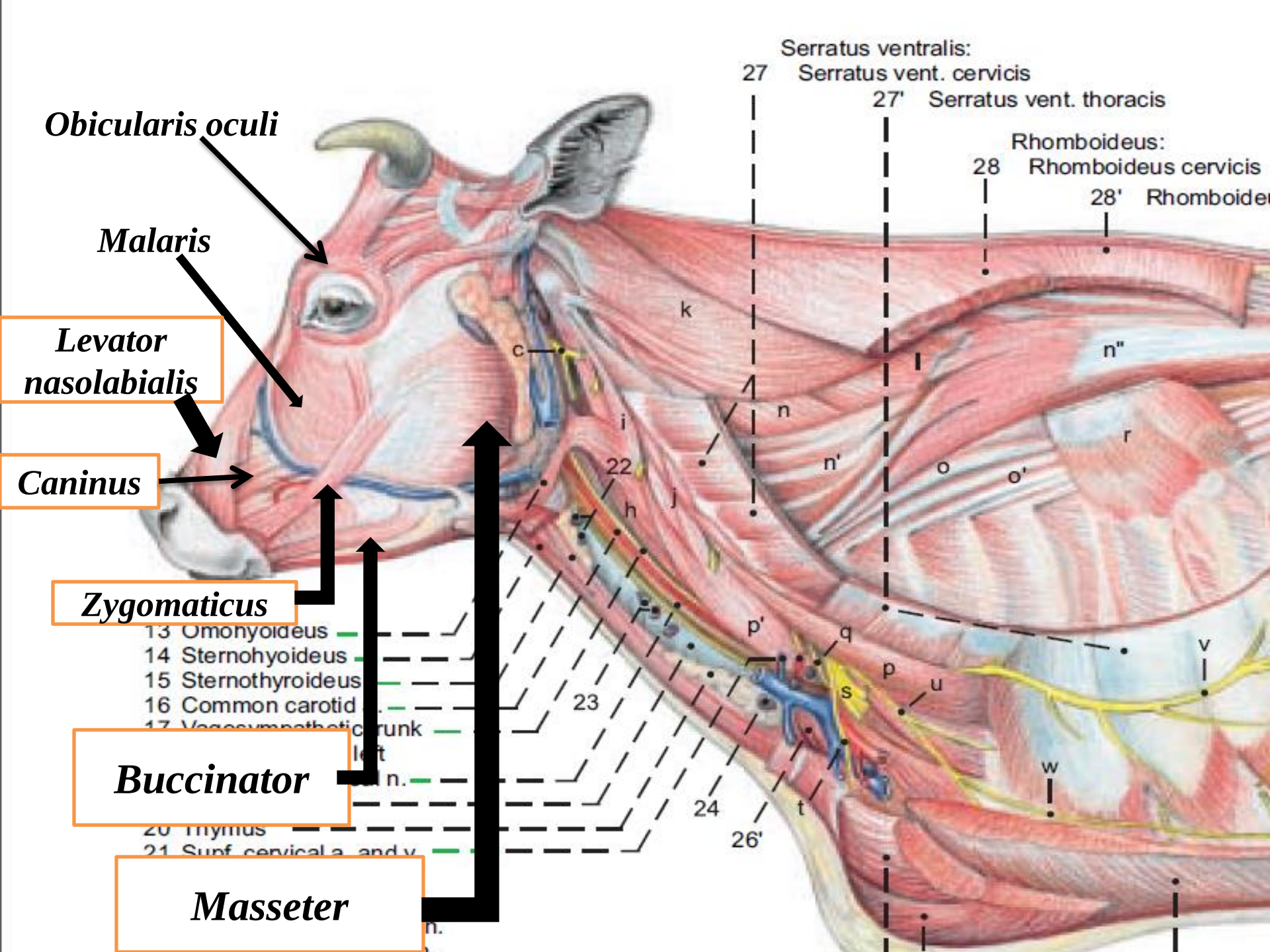
- **In camels the cutaneous muscles are limited to the head and prepuce regions.**

Cutaneous muscles



2. Muscle of The Head

- The muscle of the head may be divided into four groups:
  - Superficial muscles (muscles of the muzzle, nostril, lips and cheeks)
  - Orbital muscles
  - Mandibular muscles
  - Hyoid muscles


Obicularis oculi
Malaris
Levator nasolabialis
Caninus
Zygomaticus
Buccinator
Masseter
Serratus ventralis:
27 Serratus vent. cervicis
27' Serratus vent. thoracis
Rhomboideus:
28 Rhomboideus cervicis
28' Rhomboideu
13 Omohyoideus
14 Sternohyoideus
15 Sternothyroideus
16 Common carotid
Vagosympathetic trunk
n.
Thymus
Supf. cervical a. and v.
22
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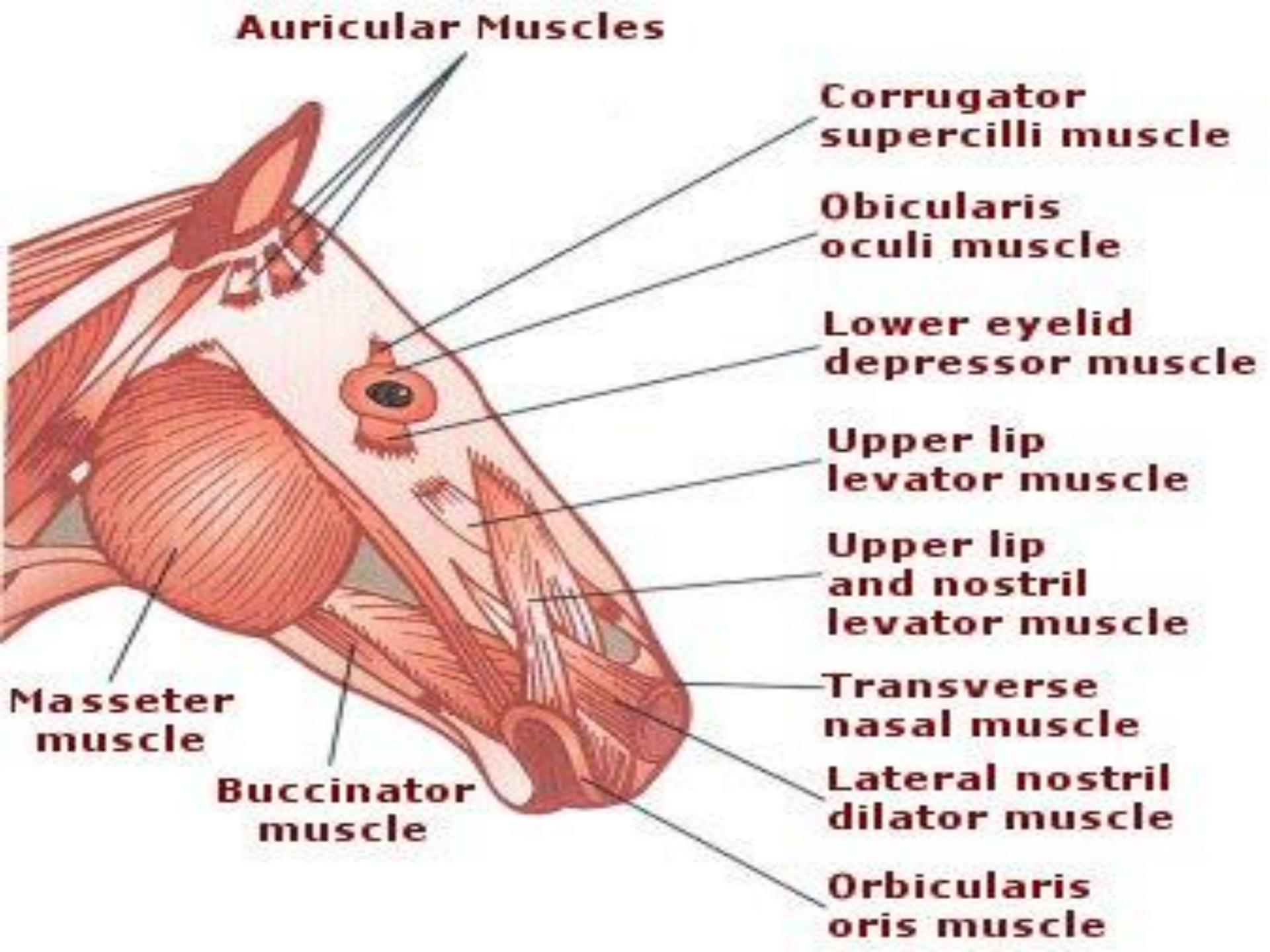

Auricular Muscles
Corrugator supercilli muscle
Obicularis oculi muscle
Lower eyelid depressor muscle
Upper lip levator muscle
Upper lip and nostril levator muscle
Transverse nasal muscle
Lateral nostril dilator muscle
Orbicularis oris muscle
Masseter muscle
Buccinator muscle

❖Muscles of the muzzle, nostril, lips and cheeks

a. Caninus: is a thin triangular muscle.

- *Location*- lies on the lateral region of the cheek, and passes between the two branches of the *levator nasolabialis*.
- *Origin*- the maxilla, close to the rostral extremity of the facial crest.
- *Insertion*- to the lateral wing of the nostril.
- *Action*- to dilate the nostril.
- *Relation*- superficially,
  - ✓ the skin fascia and
  - ✓ the labial branch of the levator nasolabialis;

  deeply,
  - ✓ the maxilla and
  - ✓ the nasal branch of the levator nasolabialis**.**

b. Levator nasolabialis- is a thin muscle

- *Location*- lies directly under the skin on the lateral surface of the nasal region.
- *Origin*- frontal and nasal bones
- *Insertion*-
  - ✓maxillary lip and
  - ✓the lateral wing of the nostril as well as
  - ✓the commissure of the lip.
- *Action*- To elevate the maxillary lip and the commissure.

c. *Levator labii maxillaries*

- *Location*- lies on the dorsolateral aspect of the face partly covered by levator nasolabialis
- *Origin*- lacrimal, zygomatic & maxillary bones at their junction.
- *Insertion*- maxillary lip, by a common tendon with its fellow of the opposite side.
- *Action*- to elevate the maxillary lip, in the fullest extent result in eversion of the lip.

d. *Depressor labii mandibularis*:

- *Location*- lies on lateral surface of the molar part of the mandible, along the ventral border of the *buccinator*.
- *Origin*:
  - ✓ the alveolar border of the mandible;
  - ✓ near the coronoid process and
  - ✓ maxillary tuber in common with buccinator.
- *Insertion*- to the mandibular lip.
- *Action*- to depress and retract the mandibular lip.

e. *Orbicularis oris*

- Is the sphincter muscle of the mouth.
- *Location*- lies between the skin & the mucous membrane of the lip.
- Most of the muscle fibers run parallel to the free edge of the lips and have no direct attachment to the skeleton.
- *Action*- closes the lip.

f. Buccinator

- *Location*- in the lateral wall of the mouth, extending from the angle of the mouth to the maxillary tuber; dorsal to the depressor labii mandibularies.
- *Origin* - lateral surface of the maxilla above the interalveolar space and molar teeth & the alveolar border of the mandible at the interalveolar space.
- *Insertion*- the angle of the mouth, blending with the orbicularis oris.
- *Action*- to flatten the cheeks, thus pressing the food b/n the teeth; also to retract the angle of the mouth.

g. Zygomaticus: is a very thin muscle

- *Location*- lies immediately under the skin of the cheek.
- *Origin* - The fascia covering the *masseter* muscle below the facial crest.
- *Insertion*- to the commissure of the lips
- *Action*- to retract and raise the angle of mouth.

❖ Most muscles of the face are innervated by branches from the **facial nerves**.

❖Muscle of the eyelid and eyeball

- **Eyelid:**

a. *Orbicularis oculi*:

- A flat sphincter muscle in and around the eyelids.
- It is attached to the skin of the lids but some bundles are attached to the palpebral ligament at the medial canthus and to the lacrimal bone.
- *Action*: to close the lids.

b. *Malaris*:

A very thin muscle extending from the fascia rostral to the orbit.

It found rostral to inferior lid

Action: to depress the inferior lid.

c. *Levator palpebrae superioris*:

- A flat muscle located almost entirely within the orbit.
- *Action*: to elevate the superior lid.
  - The first two muscles are innervated by the **facial nerve** while the third one is by the **oculomotor nerve**.

❖ **Muscles of the eyeball will be described under the topic of 'Sense organs' in second semester.**

❖ ***Auricular muscles*:**

- Are roughly divided into a **rostral** and a **caudal** group.
- Their contraction produces the range of ear movements characteristic of domestic animals.

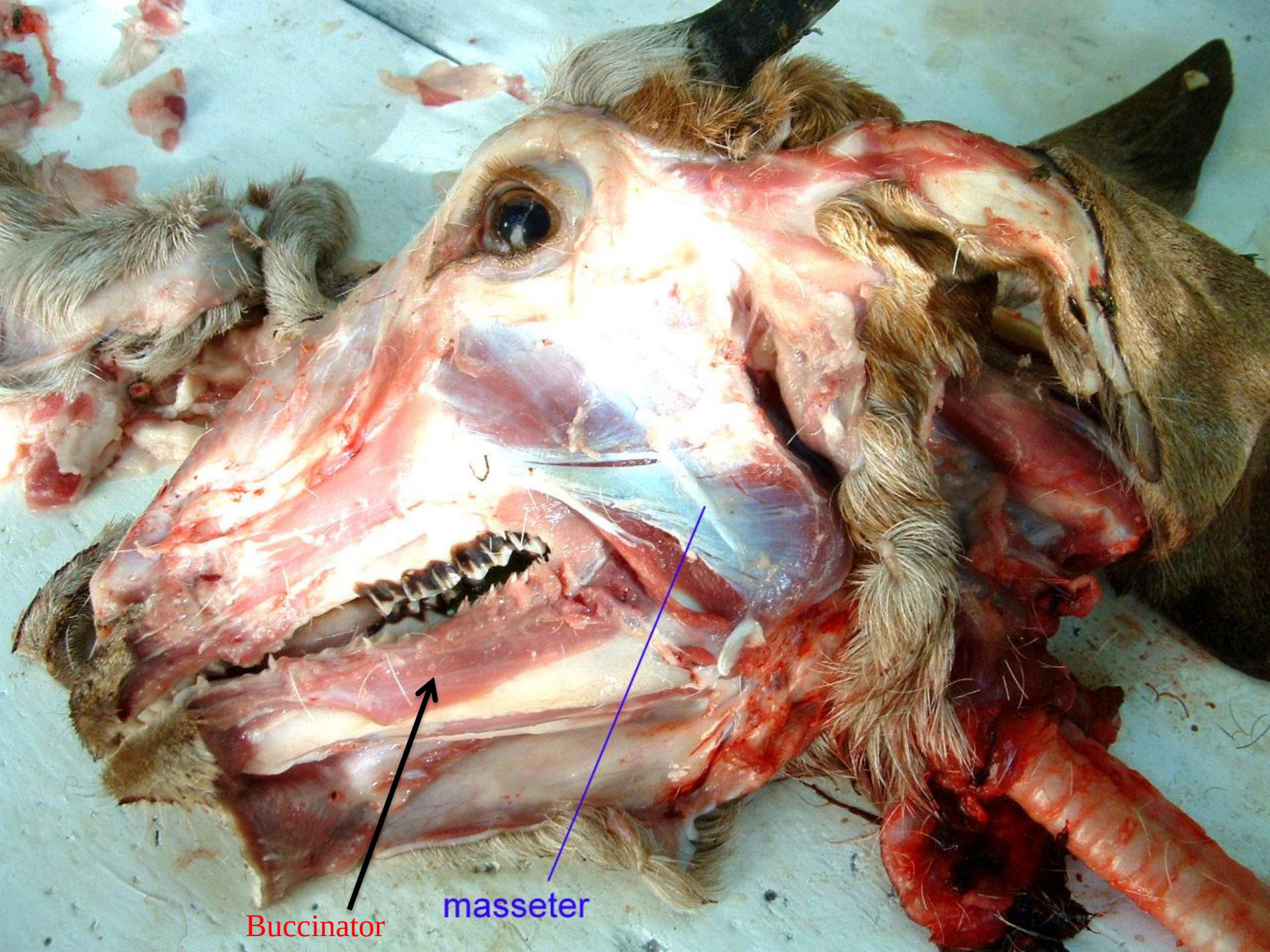
Mandibular muscles (muscles of the mastication)

- They are a number of muscles, which all arises from maxilla & the cranium, and are all inserted into the mandible and whose contractions produce the jaw movements associate with chewing.
- Most of the muscles of mastication are innervated by the **trigeminal nerve**

The important ones are:

a. *Masseter*: powerful masticatory muscle

- *Location*- it extends from the zygomatic arch & facial crest over the broad part of the lateral mandibular ramus.
- *Origin*: from the maxillary region of the face and the zygomatic arch.
- *Insertion*: on the caudal mandible
- *Action*: to elevate the mandible and to draw it lateral.


Buccinator
masseter

- Acting singly, it also carries the mandible towards the side of the contracting muscle.
- Structure - the superficial part of the muscle in its dorsal part is covered by a strong, **glistening aponeurosis**.
- This muscle is commonly examined for the presence of *cysticercus bovis* (tapeworm).
- Well developed in herbivorous species and forms broad expanse of the horse's cheek.
- In camels the masseter is situated relatively far caudally, which enables the camel to open its jaw very widely.

b. *Temporalis*: is a strong muscle

- *Location*- occupies the temporal fossa.
- *Origin*- the temporal fossa and the sagittal crest which limit it.
- *Insertion*- the coronoid process of the mandible.
- *Action*- to raise the mandible, bringing the upper and lower teeth together.

c. ***Pterygoideus medialis***

- *Location*- occupies a position on the medial surface of the ramus of the mandible similar to the masseter laterally.
- *Origin* - the crest formed by the pterygoid process of the basisphenoid and palatine bones.
- *Insertion*- the medial surface of the ramus of the mandible and the medial of the ventral border.
- *Action* - to raise the mandible together with *pterygoideus lateralis*.

d. *Pterygoideus lateralis*

- Is smaller than the preceding muscle, and situated lateral to its dorsal part.
- Play an important role in the side-to-side grinding movements typical of herbivore mastication.

e. *Digastricus*

- Is composed of two fusiform flattened bellies, united by a round tendon which are indistinctly divided near the muscle's center.
- It is covered by part of parotid gland.
- *Origin* - from the region caudal to the temporomandibular joint and the jugular process of the occipital bone.

- *Insertion*- the medial surface of the ventral border of the molar part of the body of the mandible.
- *Action*- assists in depressing the mandible and opening of the mouth.
- If the mandible is fixed & both bellies contract, the hyoid bone and the base of the tongue are raised as in the first phase of deglutition.

- A large number of muscles associated with the pharynx and soft palate are important in ***deglutition (swallowing) and phonation (vocalization)*** and
- Their various functions are to lift or depress the palate and to constrict or dilate the pharynx.
- There are also muscles which arise and inserted on hyoid apparatus which act to move the hyoid apparatus relative to the tongue and larynx.

- ❖ The tongue of domestic animals has two types of muscles:
- ✓ The ***intrinsic muscles*** of the tongue are arranged in fascicles that run longitudinally, transversely, and vertically, allowing the tongue to change shape in multiple planes.
- ✓ The ***extrinsic muscles*** of the tongue are those that arise from outside the tongue, include the ***m. genioglossus, m. hyoglossus*** and ***m. mylohyoideus*** which draws the tongue rostral, caudal and lifts the floor of the mouth, respectively.

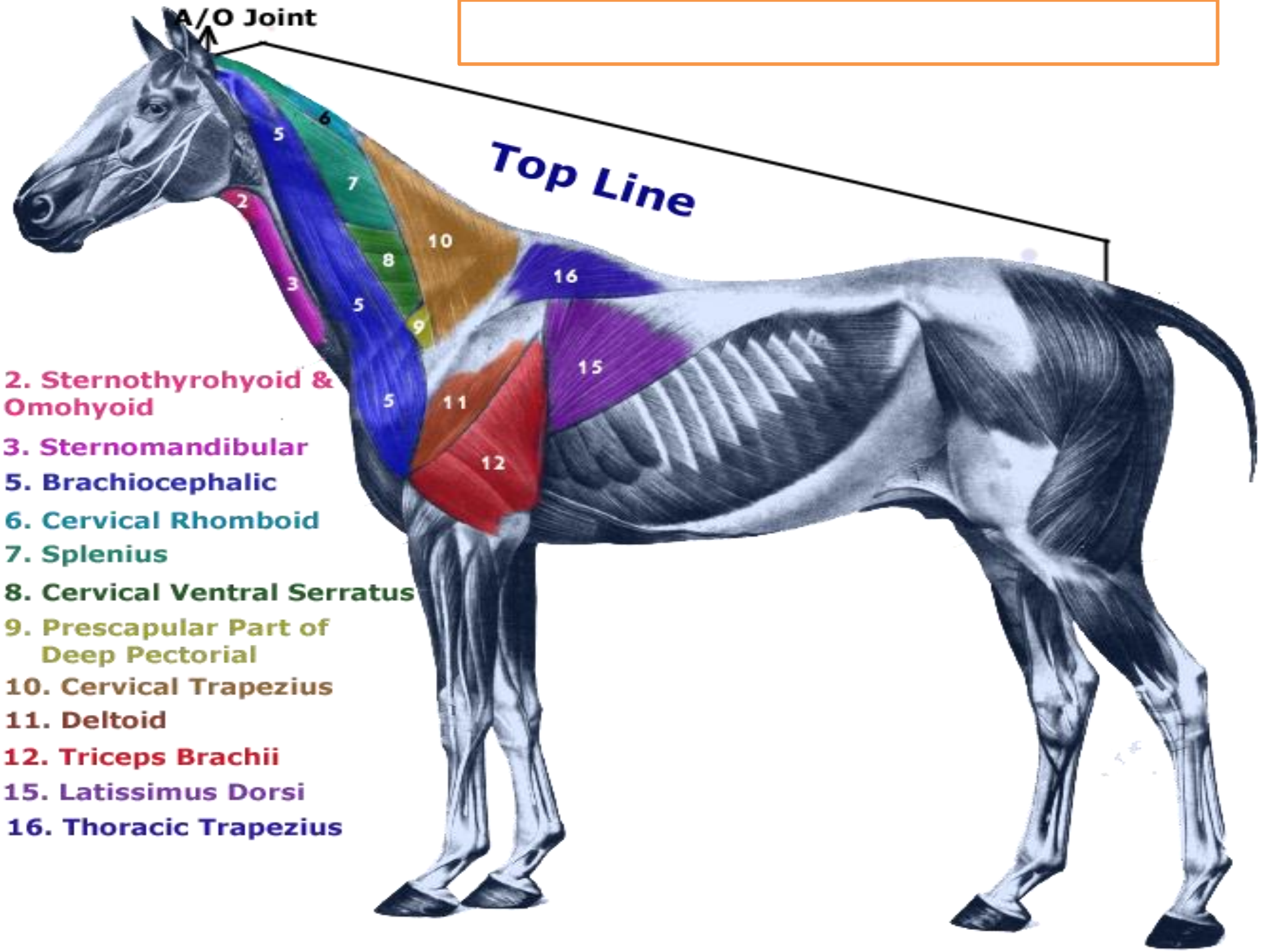
3. Muscles of the Neck

- They are divided into ventral cervical muscles and lateral cervical muscles

a) Ventral cervical muscles: consists of **12** pairs of muscle which lie ventral to the vertebrae.

Two of which are large in size and cover greater ventral surface of the neck are:

- ✓ Brachiocephalicus and
- ✓ Sternocephelicus


A/O Joint
Top Line
2. Sternothyrohyoid & Omohyoid
3. Sternomandibular
5. Brachiocephalic
6. Cervical Rhomboid
7. Splenius
8. Cervical Ventral Serratus
9. Prescapular Part of Deep Pectorial
10. Cervical Trapezius
11. Deltoid
12. Triceps Brachii
15. Latissimus Dorsi
16. Thoracic Trapezius

1. Brachiocephalicus:

- Location - it extends along the side of the neck from the head to the arm.
- *Origin*- from
  - the petrous part of the temporal bone,
  - the nuchal crest,
  - wing of the atlas and
  - transverse processes of the 2^{nd} to 4^{th} cervical vertebrae.
- *Insertion*- deltoid tuberosity and crest of the humerus.
- Action- When the head and neck are fixed, to draw the limb cranially extending the shoulder joint.
- When the limb is fixed, to extend the head and neck if the muscles on either side act together.

- In camels this muscle is reduced or absent.
- *Relation*- The ventral edge of the muscle forms the dorsal boundary of the jugular furrow or groove.

2. Sternocephalicus

- It is the long narrow muscle, which extends along the ventral and lateral aspect of the trachea from the sternum to the angle of the mandible.
- It forms the ventral bounder of the jugular furrow.
- *Origin*: The cartilage of the manibrum.
- *Insertion*: caudal border of the ramus of the mandible.

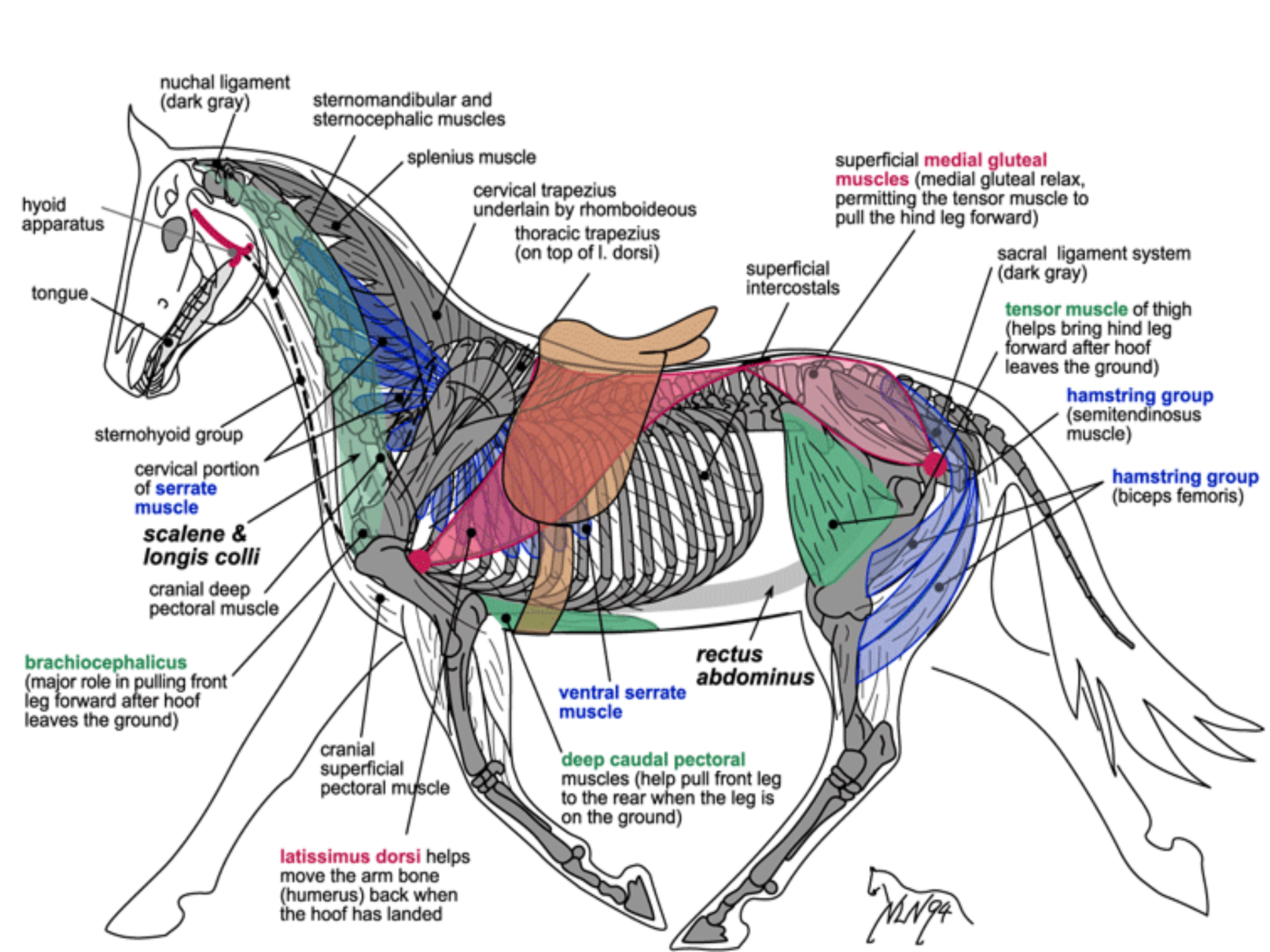
- *Action*- acting together, to flex the head and neck.
- Acting singly, to incline the head and neck to the side of contraction of the respective muscle.
- *Relation*: The dorsal edge of the muscle is related to the external jugular vein and to the common carotid artery and vagus nerve.

b) Lateral cervical muscles

- This group also consists of 12 pairs of muscles arranged in layers on either sides of the neck.
- Because they form a thick layer, these muscles are commonly used for **intramuscular injections in equine species** as the gluteal muscles cannot be used for the sake of safety of the veterinarian.

First layer - *Trapezius*

Second layer - *Rhomboideus cervicis* and *Serratus ventralis cervicis*


nuchal ligament (dark gray)
sternomandibular and sternocephalic muscles
splenius muscle
hyoid apparatus
cervical trapezius underlain by rhomboideous
thoracic trapezius (on top of l. dorsi)
superficial medial gluteal muscles (medial gluteal relax, permitting the tensor muscle to pull the hind leg forward)
sacral ligament system (dark gray)
superficial intercostals
tongue
tensor muscle of thigh (helps bring hind leg forward after hoof leaves the ground)
hamstring group (semitendinosus muscle)
sternohyoid group
cervical portion of serrate muscle
hamstring group (biceps femoris)
scalene & longis colli
cranial deep pectoral muscle
brachiocephalicus (major role in pulling front leg forward after hoof leaves the ground)
rectus abdominus
ventral serrate muscle
cranial superficial pectoral muscle
deep caudal pectoral muscles (help pull front leg to the rear when the leg is on the ground)
latissimus dorsi helps move the arm bone (humerus) back when the hoof has landed

- **Third layer**

❖ ***Splenius*** **-** An extensive flat triangular muscle covered by preceding three muscles.

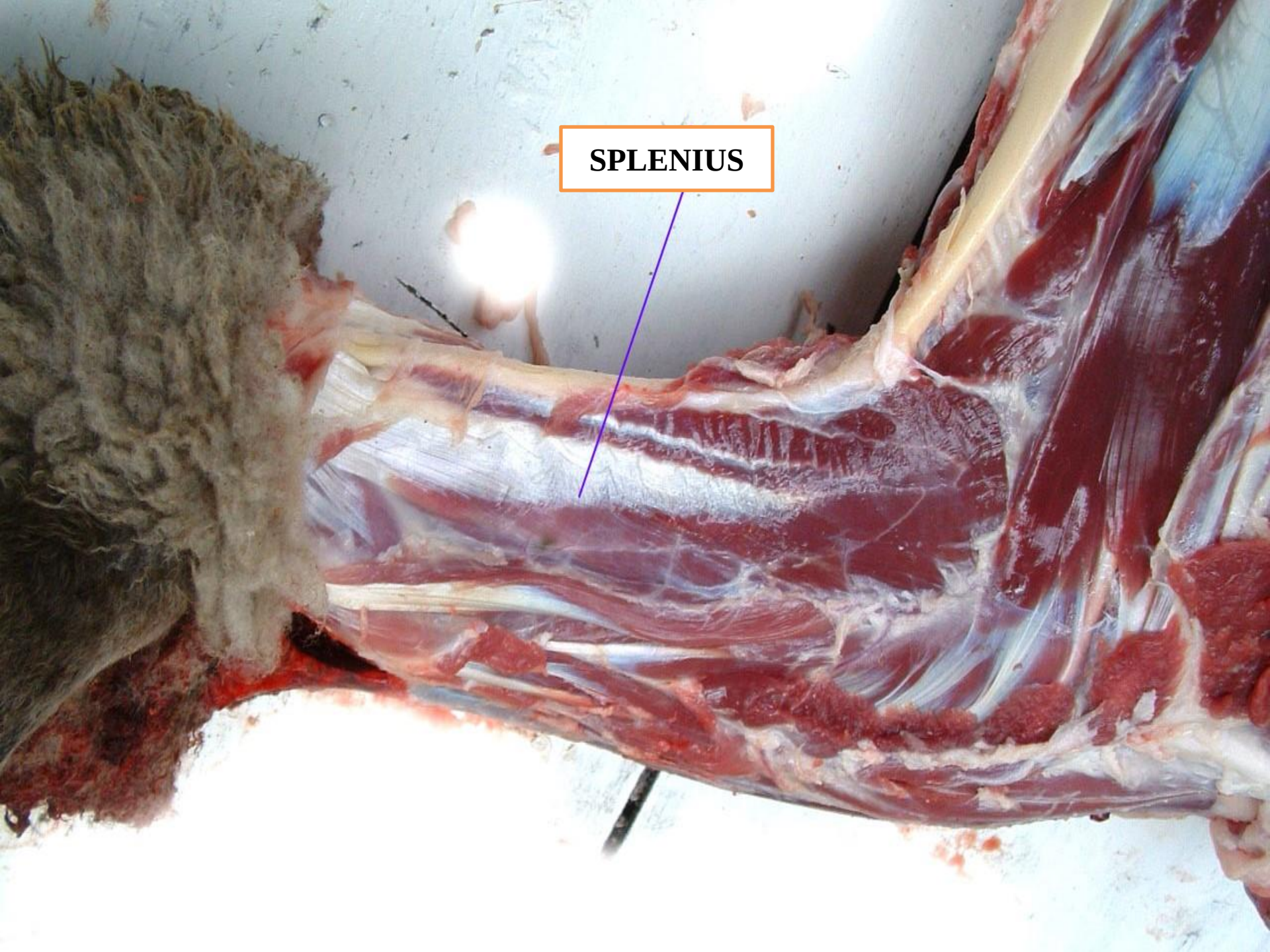
➢ *Origin* - the 3rd, 4th and 5th thoracic spines.

➢ *Insertion*-

- ✓ The nuchal crest,
- ✓ mastoid process of temporal bone,
- ✓ wing of the atlas and
- ✓ the transverse processes of the 3rd, 4th and 5th cervical vertebrae.

➢ *Action*- acting together, to elevate the head and neck.

➢ Acting singly, to incline the head and neck to the side of the respective muscle.


SPLENIUS

- **Fourth layer**

❖ ***Longissmus capitis et atlantis***: Consists of two parallel fusiform portions.

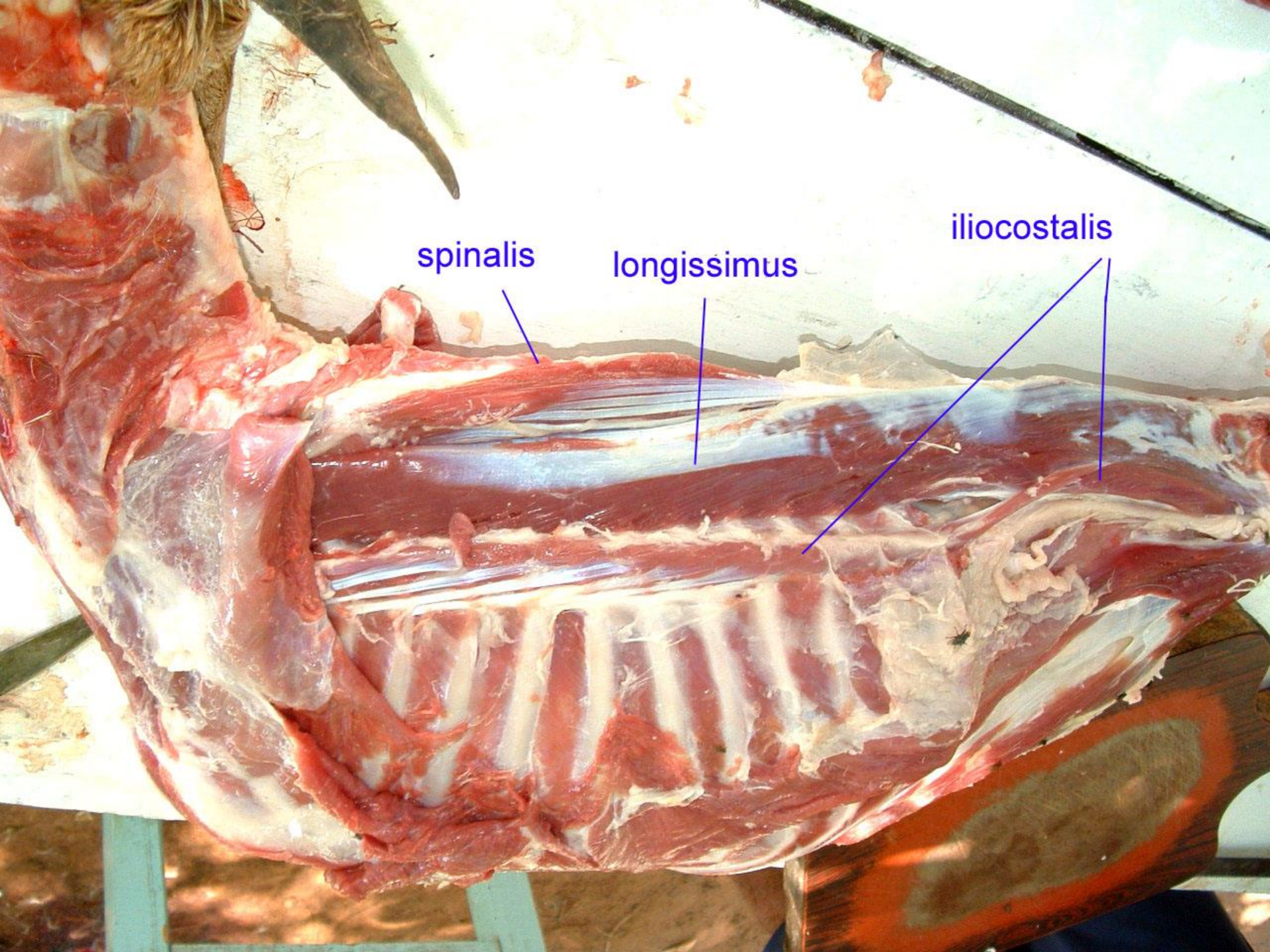
➢ *Location*- it lies between the deep face of *splenius* and the *complexus*.

➢ *Origin*- transverse processes of the first two thoracic and the articular processes of the cervical vertebrae.

➢ *Insertion*- The mastoid process and wing of the atlas.

➢ *Action*- acting together, to extend the neck and head.

➢ Acting singly, to flex the head and neck laterally.


spinalis
longissimus
iliocostalis

❖***Semispinalis capitis***: is a large triangular muscle which lies chiefly on the nuchal ligament under the cover of the splenius.

Origin-

- ✓From the 3rd to 5th thoracic spines,
- ✓transverse processes of the 1st six or seven thoracic vertebrae and,
- ✓the articular processes of the cervical vertebrae.

Insertion - to the occipital bone just ventral to the nuchal crest.

Action- it is the chief extensor of the head and neck.

4. Muscles of the back and loin

- The groups of muscles located dorsal to the transverse processes of the vertebrae on either side of the spinous process making up the **loin muscles** and continue forward to the head.
- There are nine pairs of muscles in the region of back and loin, which are arranged in four layers.

First layer: *trapezius* and *latissimus dorsi*.

Second layer: *Rhomboidus thoracis*, *Serratus dorsalis cranialis* and *serratus dorsali caudalis*.

Third layer: ***Longismus muscle***

- Includes *longissmus lumborum, thoracis, and cervices*.
- It is the largest and the longest muscle of the body.
- *Location*: Extends from the sacrum and ileum to the neck.
- It fills up the space between the spinous processes medially and the lumbar transverse processes and dorsal end of the ribs ventrally.
- *Origin –*
  - ✓the tuber, crest and adjacent part of the ventral surfaces of the ileum;
  - ✓the first three sacral spines,
  - ✓lumbar and thoracic spines and
  - ✓the supraspinous ligament.

- *Insertion* —
  - ✓lumbar transverse process,
  - ✓thoracic transverse process,
  - ✓spinous and transverse processes of the last four cervical vertebrae and
  - ✓lateral surface of the ribs except the first one.
- *Action*- it is the most powerful extensor of the back and loins; by its cervical attachment it assists in extending the neck.
- With its costal attachment it assist in expiration.
- Acting singly, it flexes the back laterally.

5. Muscle of the thorax

- It consists of **seven** muscles
- Are attached to thoracic vertebrae, the ribs and their cartilage and the sternum.
- They are the muscles of respiration.

- **External intercostal muscle**

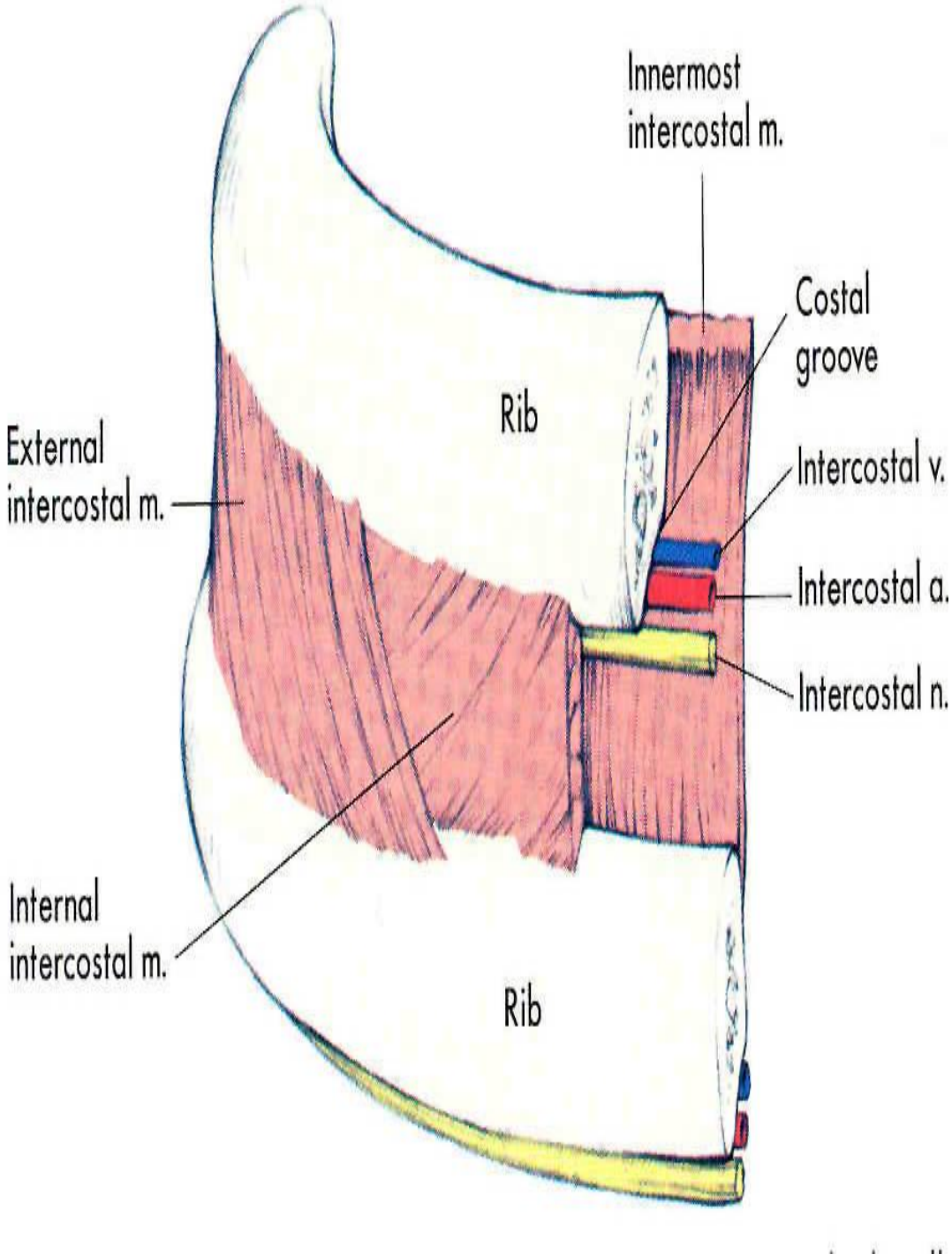
- *Location*- it occupies an intercostal space from the dorsal end of the intercostal space to the sternal extremity of the rib.
- They don't occupy the intercartilaginous space.
- *Origin*- the caudal border of the ribs.

- *Insertion*- the cranial borders and lateral surfaces of the succeeding rib.
- *Action*- to draw the ribs **cranial in inspiration**.
- *Structures* - the fibers are directed in oblique caudoventrally.

- **Internal intercostal muscle**

- *Location*- it extends the entire length of the intercostal spaces, including their interchondral portion.
- *Origin*- the cranial borders of the ribs & their cartilages.
- *Insertion*- The caudal borders of the preceding ribs & cartilages.
- *Action*- to draw the ribs **caudally during expiration**.
- *Structures* - The fibers are directed in oblique cranioventrally.

External internal muscle


Innermost
intercostal m.
Costal
groove
Rib
External
intercostal m.
Intercostal v.
Intercostal a.
Intercostal n.
Internal
intercostal m.
Rib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- **Diaphragm:**

➢ Is a broad, unpaired muscle.

➢ Forms a partition between the thorax and abdominal cavities.

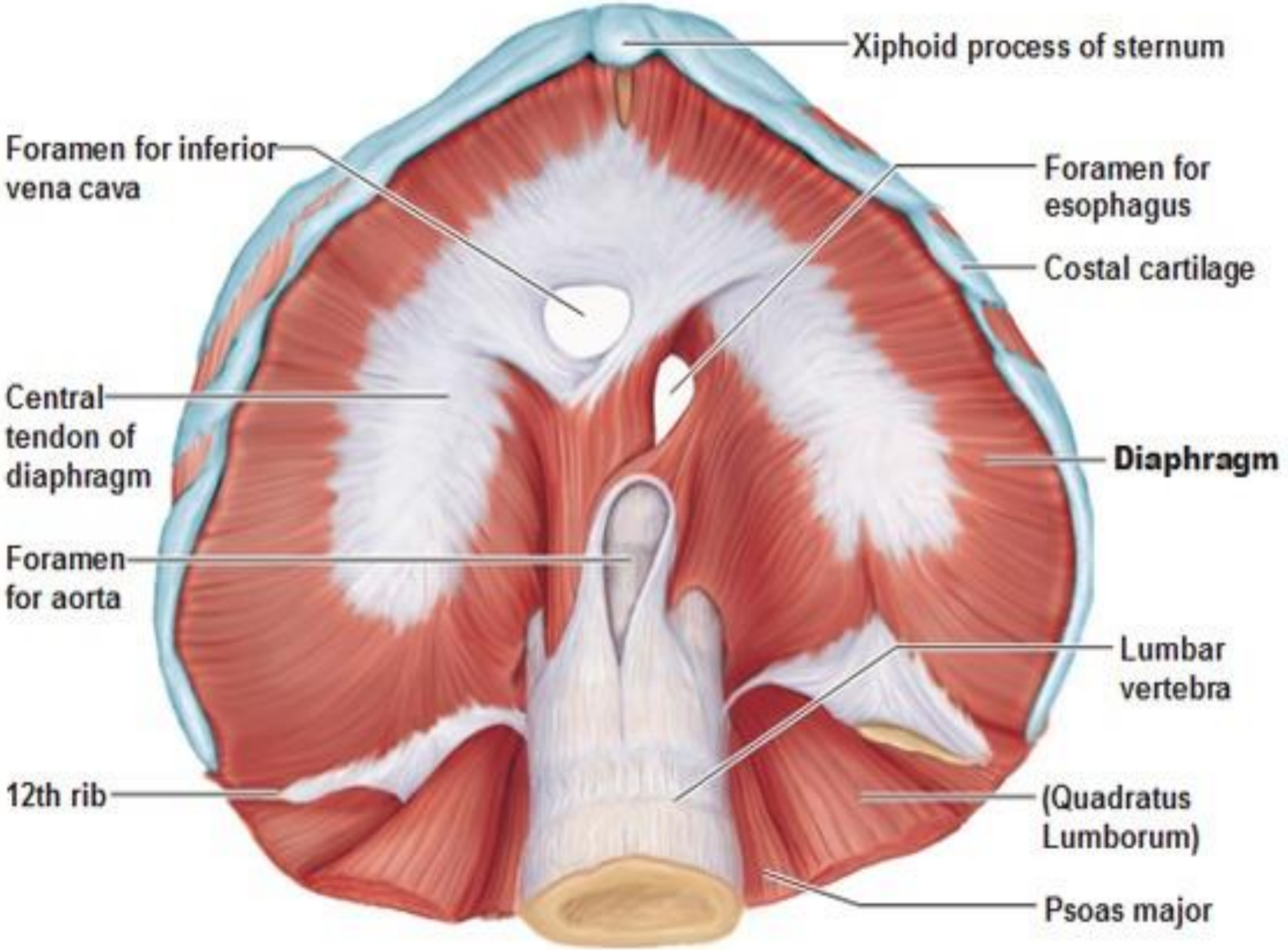
➢ Has a dome shape.

➢ It consists of a fleshy rim subdivided into

  ✓ costal and sternal parts;

  ✓ a lumbar part, composed of two crura; and

  ✓ a tendinous center.


Xiphoid process of sternum
Foramen for inferior vena cava
Foramen for esophagus
Costal cartilage
Central tendon of diaphragm
Diaphragm
Foramen for aorta
Lumbar vertebra
12th rib
(Quadratus Lumborum)
Psoas major

- *Attachment*:

➢ The costal part is attached to the cartilage of the 8^{th}-10^{th} ribs,

➢ The sternal part is to the dorsal part of the xiphoid cartilage and

➢ The lumbar part is attached to the 1^{st}-4^{th} or 5^{th} lumbar vertebrae by means of the ventral longitudinal ligament.

➢ *Action*- the principal muscle of inspiration & increases the longitudinal diameter of the chest.

- **In expiratory phase** the costal part and crural lies almost entirely on the body walls.

➢ So that the base of the lungs are in contact with the tendinous center almost exclusively.

- **In ordinary inspiration** the fleshy rim recedes from the chest wall.

➢ So, that the base of the lung move caudal to line about parallel with costal arches & about 10-12cm there from.

The diaphragm is pierced by **three foramina**:

- **Aortic hiatus-** it contains the descending aorta, right vena azygous, and cisterna chyli
- **Oesophageal hiatus-** it perforates the right crus near its junction with the tendinous center.

It transmits the esophagus, the dorsal & ventral vagus nerve, esophageal branch of the left gastric artery & a serous sac, or infracardial bursa.

- **Foramena vena cavae -** it pierces the tendinous center about 2-3cm to the margin of the opening.

- **Relation**

➢ the thoracic surface is related to pleura, pericardium, and the base of the lungs and the ribs in part,

➢ while the abdominal surface is covered with the peritoneum & is related to the liver, stomach, intestine, spleen, pancreas, kidneys & adrenals.

- **Nerve supply-** The phrenic & intercostal nerves innervate the diaphragm.

6. Abdominal muscles and fascia

- The **superficial fascia** of the abdomen is in part fuses:

➢ dorsally with the thoracolumbar fascia,

➢ cranially it is continuous with the superficial fascia of the shoulder and arm,

➢ caudally with that of the gluteal region and

➢ medially it blends with linea alba.

- The **deep fascia** is represented chiefly by the abdominal tunic.

➢ This is a sheet of elastic tissue that assists the muscles in supporting the great weight of the abdominal viscera.

➢ It is intimately adherent to the aponeurosis of the *obliques externus abdominis* muscle ventrally.

➢ **Linea alba** is a median fibrous raphe which extend from the xiphoid cartilage to the prepubic tendon.

- It is formed chiefly by the junction of the aponeurosis of the *obliquus externus* and *internus abdominis* and *transverse abdominis* muscles, but partly by longitudinal fibers.

Abdominal Musculature

1. *Obliques externus abdominis*

- It is the most extensive of abdominal muscles.
- *Origin*: from the lateral surface of the ribs caudal to the fourth rib and the fascia over the *intercostalis externi muscle* and the thoracolumbar fascia.
- *Insertion*- to the linea alba, prepubic tendon, and body of the ileum.

Structure- it is a flat muscle composed of muscular and aponeurotic parts.

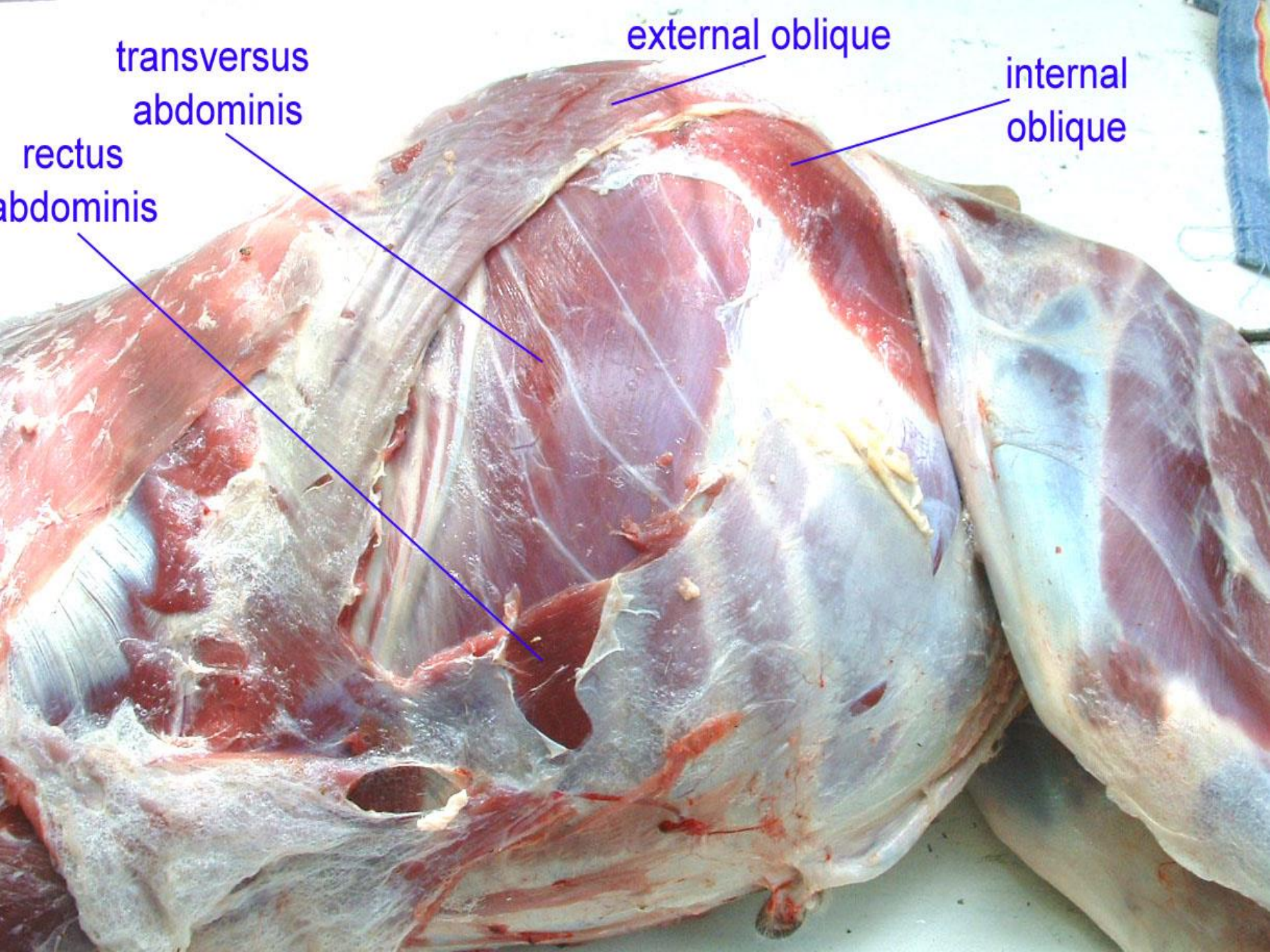
-Its fibers are directed ventrally and caudally.

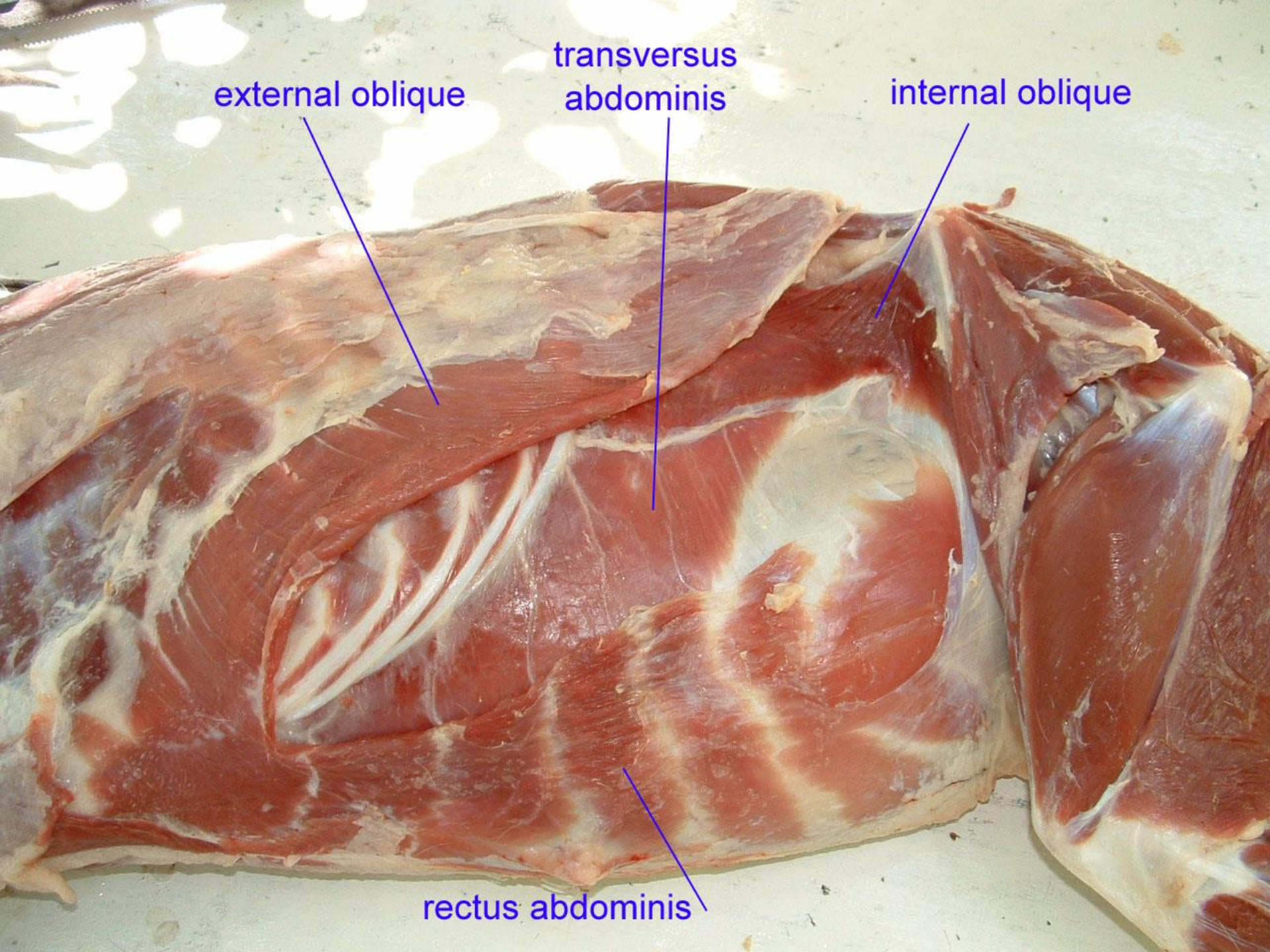
Action- to compress the abdominal viscera as in defecation, micturition, parturition and expiration.

It also helps to flex or arch the back.

- ***Obliques internus abdominis***

- It is located under the preceding muscle.
- *Origin*: from the coxal tuber and adjacent part of the inguinal ligament.
- *Insertion*: to the cartilage of the last four or five ribs, the linea alba and the prepubic tendon.
- *Action*- similar to the *oblique externus abdominis*.
- *Structure*: it is a flat sheet of muscle composed of both muscular and aponeurotic parts.
- The fibers are directed ventrally and cranially.
- It forms the caudal wall of the inguinal canal.


external oblique
transversus abdominis
internal oblique
rectus abdominis


external oblique
transversus abdominis
internal oblique
rectus abdominis

- ***Tranisversus abdominis muscle***

➢ It is the deepest muscle of the abdominal muscles.

➢ *Origin*: medial surface of the ventral ends or the cartilage of asternal ribs and transverse process of the lumbar vertebrae.

➢ *Insertion*: Xiphoid cartilage and Linea alba.

➢ *Structure*: Its dorsal part is muscular and its ventral part is aponeurotic.

➢ ***Rectus abdominis***

It forms the floor of the abdomen.

Origin: cartilage of the ribs and sternum

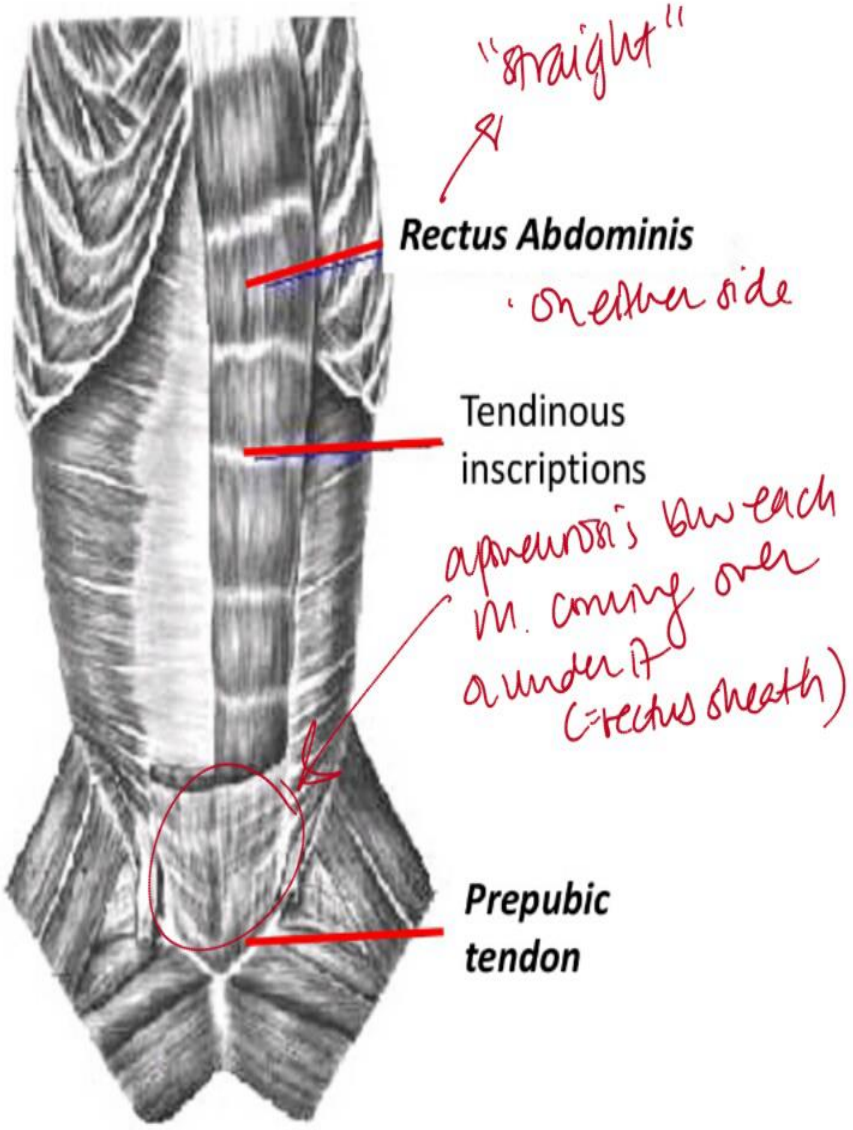
Insertion: to the pubis by means of prepubic tendon.

Structure: the fibers are directed longitudinally

Muscles of the abdominal wall

Rectus Abdomonis (RA)

Sternum to prepubic tendon



Rectus Sheath

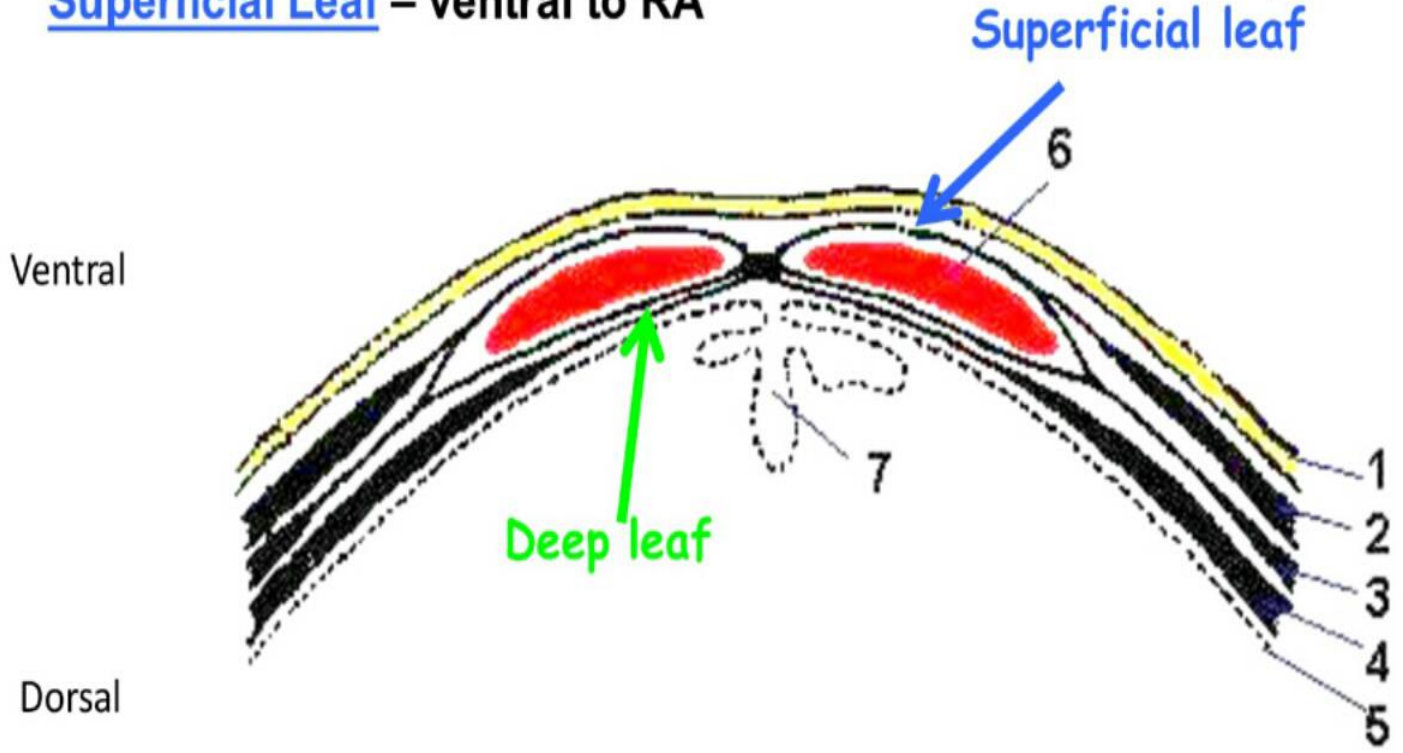
Fused aponeuroses of abdominal muscles surrounding

Rectus abdominis (RA) muscles

L apo of contoured rec. abd. mm
of sup. leaf + deep leaf
L ventral L dorsal

Deep Leaf - dorsal to RA

Superficial Leaf – ventral to RA

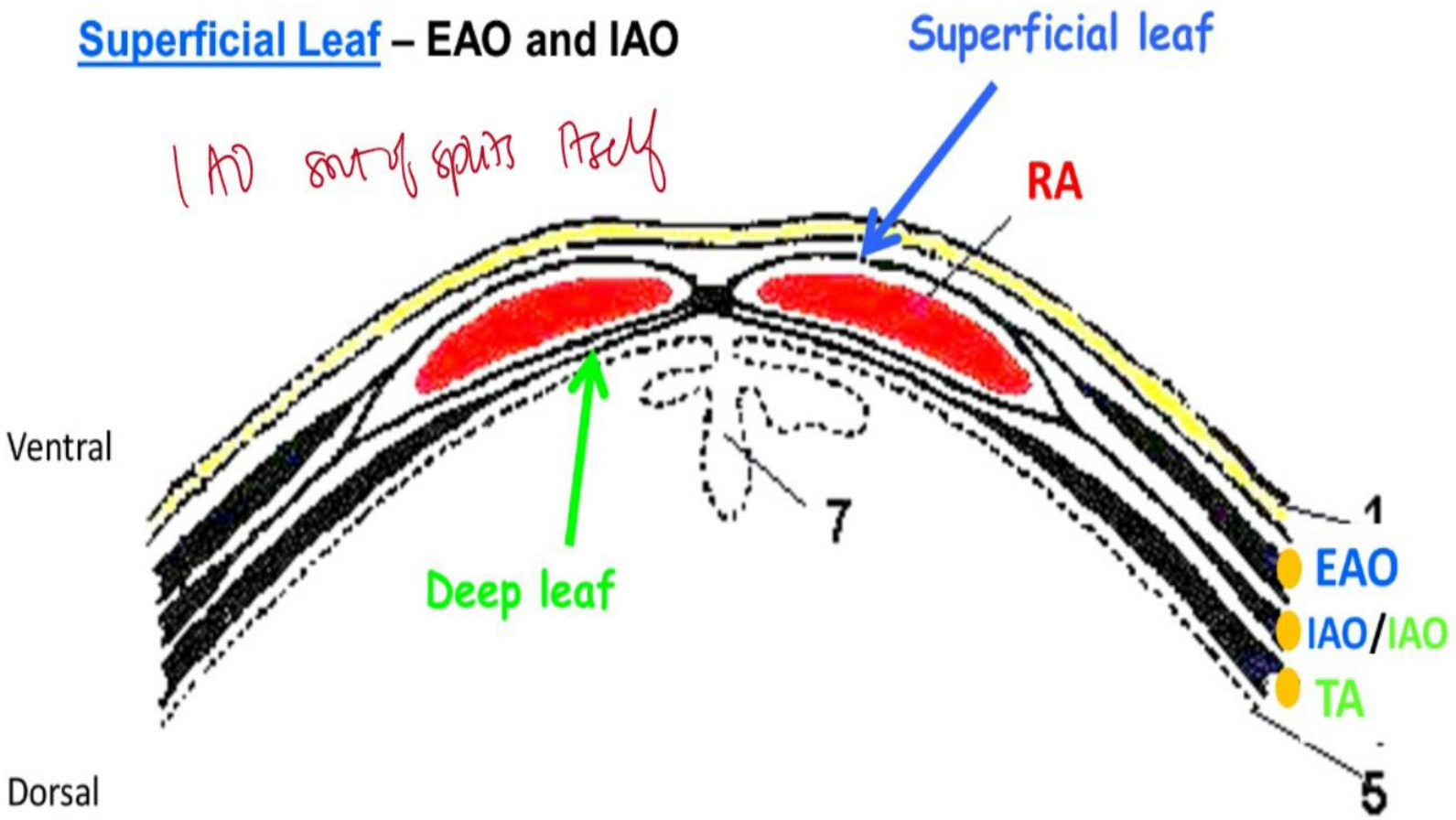


Rectus Sheath

Cranial third of Abdomen

Deep Leaf – IAO and TA

Superficial Leaf – EAO and IAO

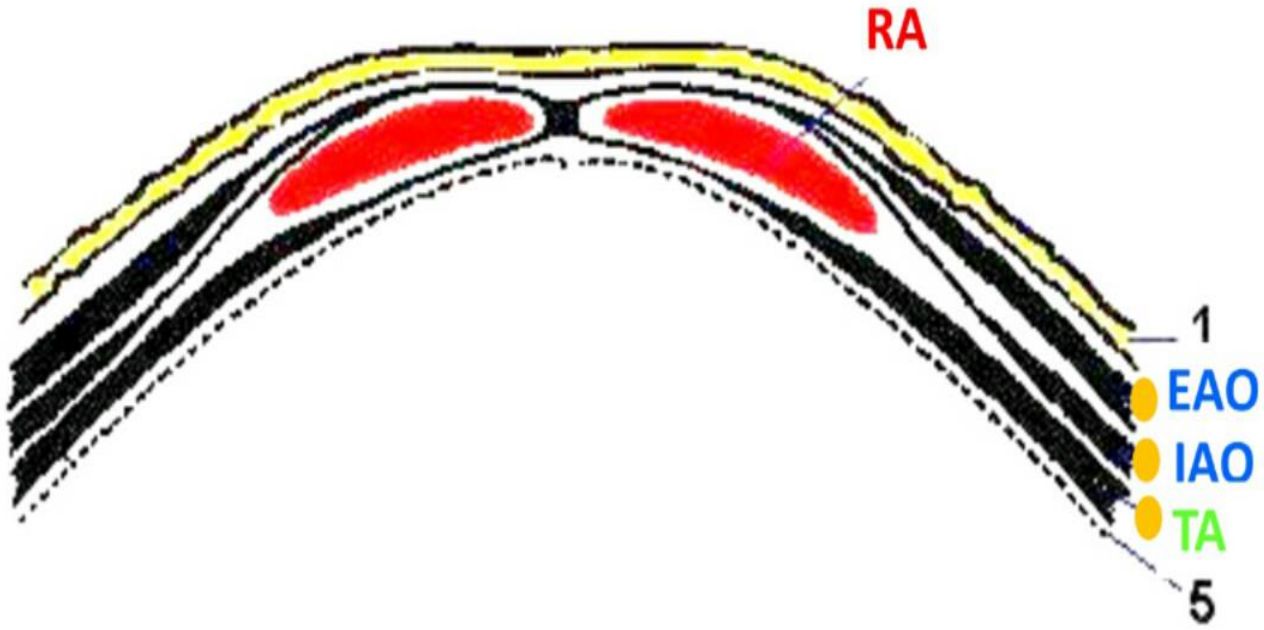


Rectus Sheath

Middle third of Abdomen

Deep Leaf – TA

Superficial Leaf – EAO and IAO



Rectus Sheath

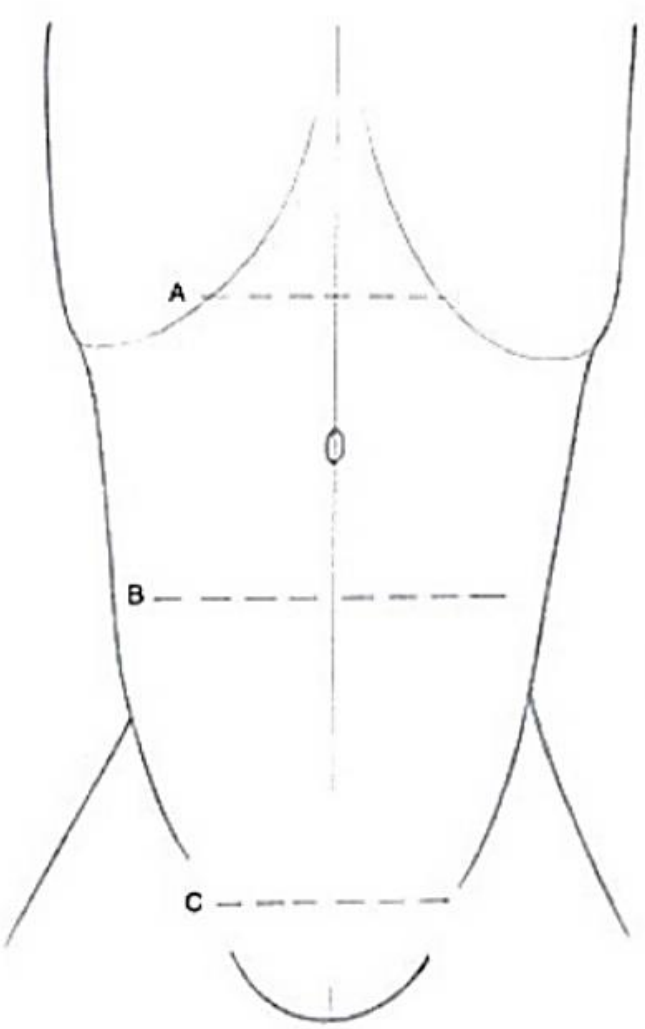
Caudal third of Abdomen

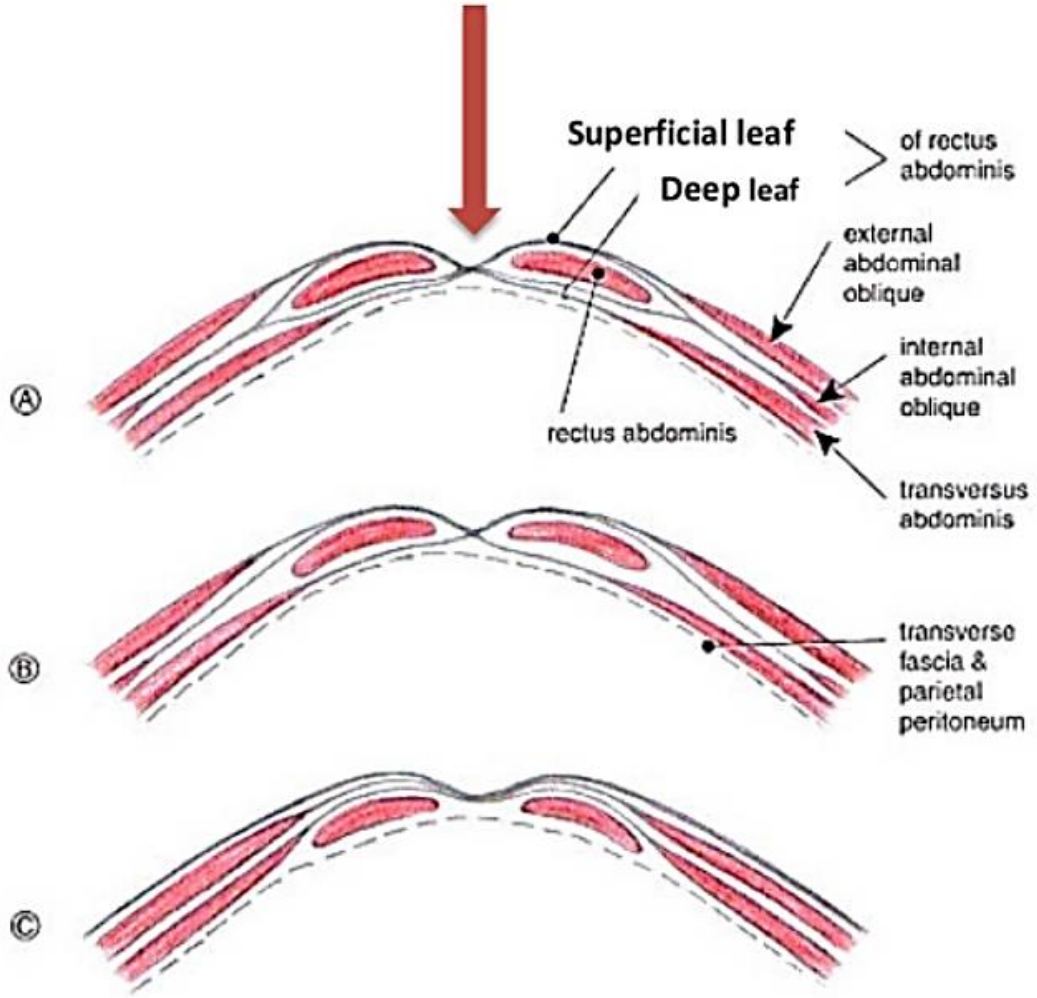
Deep Leaf – absent

Superficial Leaf – EAO, IAO and TA

no deep leaf in caudal 1/3!

Lina alba


A
B
C


Superficial leaf
of rectus abdominis
Deep leaf
external abdominal oblique
internal abdominal oblique
rectus abdominis
transversus abdominis
Ⓐ
Ⓑ
transverse fascia & parietal peritoneum
Ⓒ

7. Muscle of the limbs

7.1. Muscles of the thoracic limb

A. Muscles of shoulder girdle

Extrinsic Musculature

- These muscle are responsible for joining the forelimb to the head, neck and trunk forming a *synsarcosis* rather than a conventional joint.
- Collectively, they act to transfer the weight of the body to the forelimbs as well as stabilize the scapula.

- In domestic animals the chief movement of the proximal part of the thoracic limb is a pendulous swing forward and backward.
- The muscles that hold the scapula in place contribute to this swinging movement.
- These muscles are also critical in allowing the weight of the thorax to be supported between the two thoracic limbs
- It consists of two division:

Dorsal division

First layer

Trapezius

- Is a flat triangular muscle grouped under dorsal division of first layer muscle.
- *Body*: two parts, cervical and thoracic separated by aponeurosis.
- *Origin*: mid-dorsal raphe and *supraspinous* ligament, 2^{th} -10^{th} thoracic vertebrae.
- *Insertion*: spine of the scapula.
- *Action*: raises scapula against the trunk and swings cranially and dorsally to advance the limb (to elevate the shoulder).

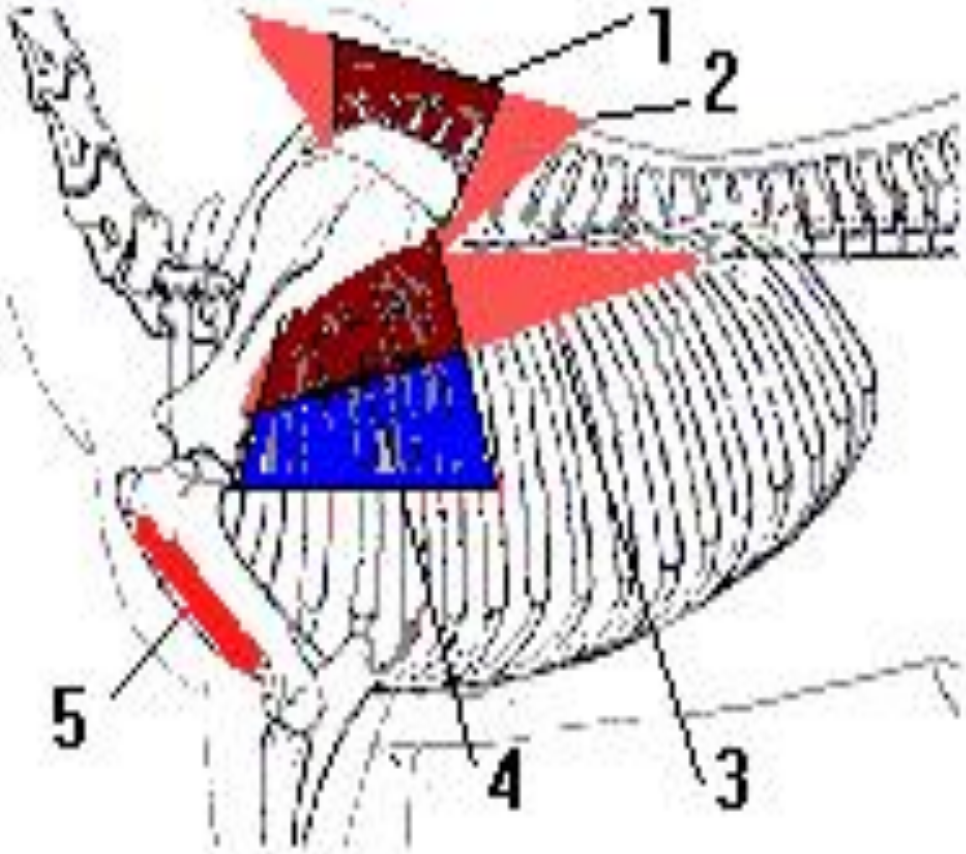
Second layer

Rhomboideus

- Forms the **hump** of bovine

Consists of two parts-*Rhomboids thoracis* and *Rhomboids cervics.*

- *Location:* Is found deep to *trapezius* that in ***zebu*** cattle it comprises the main parts of **the hump**.
- In camel, unlike zebu the hump is composed of fatty tissues.
- Forms the second layer of *brachial plexus.*
- *Origin*:
  - ✓ nuchal ligament,
  - ✓ from the 2^{nd} cervical –2^{nd} thoracic vertebrae,
  - ✓ 4^{th} – 7^{th} thoracic spinal processes.
- *Insertion*: medial surface of the cartilage of the scapula.
- *Action*: drawing the scapula dorsally and cranially, may also raise limb (thoracic part), elevating the neck when limb is fixed (cervical part).



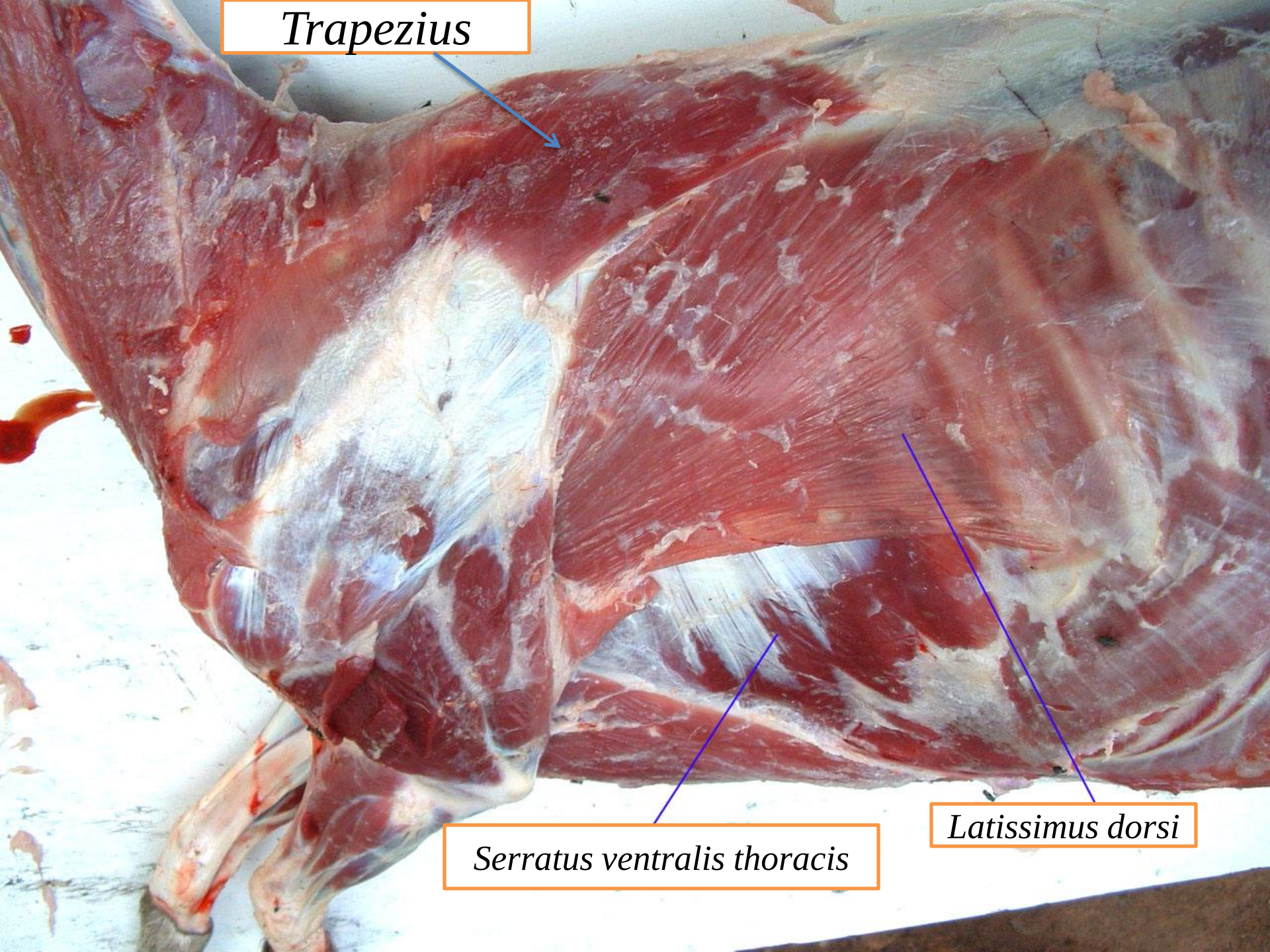
1 = Rhomboideus
2 = Trapezius
3 = Latissimus dorsi
4 = Serratus ventralis
5 = Pectoral muscles

Omotransversus

- Is a separate muscle of the shoulder region in most domestic species.
- *Origin*: from the transverse processes of the more cranial cervical vertebrae.
- *Insertion*: on the distal part of the spine of the scapula (clavicular tendon in the horse).
- *Action*: pulls the distal end of the scapula forward, although with the limb in weight bearing position, it instead assists lateral flexion of the neck.

Latissimus dorsi

- Wide muscle having right-angled triangle shape.
- The broadest muscle of the back.
- *Location*: lies on the lateral wall of the thorax from vertebral spine to the arm.
- *Origin*: thoracolumbar fascia.
- *Insertion*: teres major tuberosity of the humerus.
- *Actions*: to draw the humerus dorsally and caudally and thus to flex the shoulder joint(antagonist to the brachiocephalic muscle).
- It draws the trunk cranially if the limb is fixed and advanced.


Trapezius
Serratus ventralis thoracis
Latissimus dorsi

Ventral division

- Are large fleshy masses, occupy the space between the ventral part of the thoracic wall and shoulder and arm.

1. *Brachiocephalicus*:

- Two parts
- *Origin*:
  - dorsal part from the wing of the atlas and nuchal crest.
  - ventral part from mastoid process (caudal side of temporal bone).
- *Insertion*: the deltoid tuberosity and crest of the humerus.

- *Actions*:
  - advances the limb and extends the shoulder joint when limb is in motion.
  - draws head and neck ventrally when limb is fixed.

2. Pectorales muscles

- Are large flashy masses, which occupy the space between the ventral parts of thoracic wall and shoulder and arm.
- It is action is to adduct the forelimb
- It is divided into a superficial and deep layer.

I. *Superficial layer*

a) Pectoralis descendens*:* forms a distinct prominence cranial to presternal region which is easily recognized in the living animal.

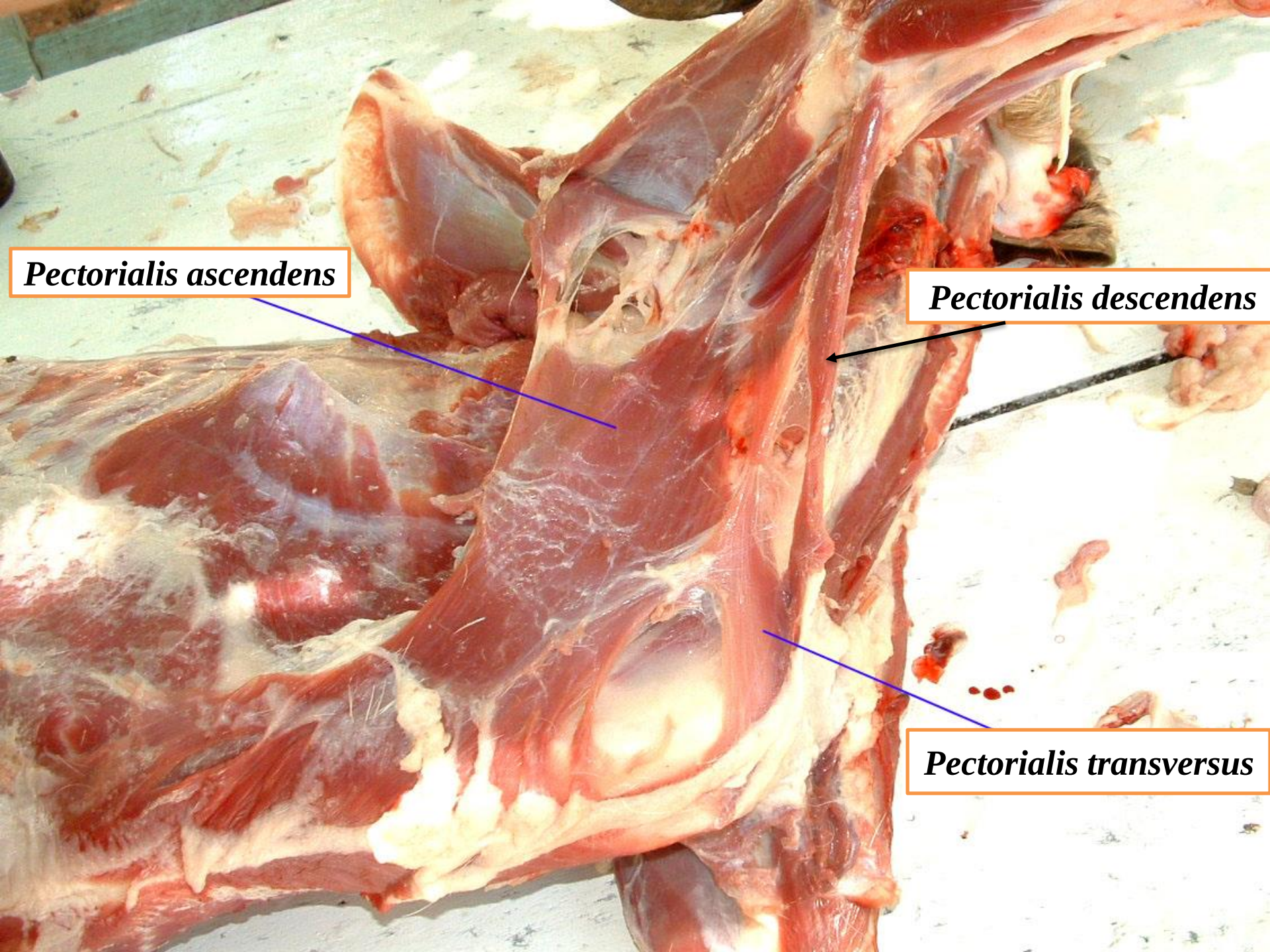
Origin: Cartilage of the manibrum.

Insertion: to the deltoid tuberosity.

b)Pectorialis transversus*:* its fibers are arranged transversally between the forelimb on the chest.

Origin: ventral edge of the sternum.

Insertion: medial surface of the elbow.


Pectorialis ascendens
Pectorialis descendens
Pectorialis transversus

II. Deep layer

c) ***Pectorial ascendens****:* is the largest of pectorial group

Origin: Xiphoid cartilage and ventral of the sternum

Insertion: cranial part of the lesser and major tuberosity of the humerus.


Pectorialis ascendens
triceps brachii
Serratus ventralis

3. *Serratus ventralis (cervicis and thoracis)*

Location: on the lateral surface of the neck and thorax and has cervical and thoracic part: *serratus ventralis cervices* and *serratus ventralis thoracis*.

Origin: the transverse processes of the last 4 or 5 cervical vertebrae and the lateral surfaces of the first 8 or 9 ribs.

Insertion: to the cranial and caudal triangular area on the costal surface of the scapula.

- *Action*: these muscles result in the caudal and cranial swing of the limb respectively.
  - cervical portion can draw the dorsal border of the scapula towards the neck.
  - caudal portion can draw the dorsal border of the scapula towards the back.
- Antagonist each other by their effect on the scapula.

Intrinsic musculature

B. Muscles of the shoulder

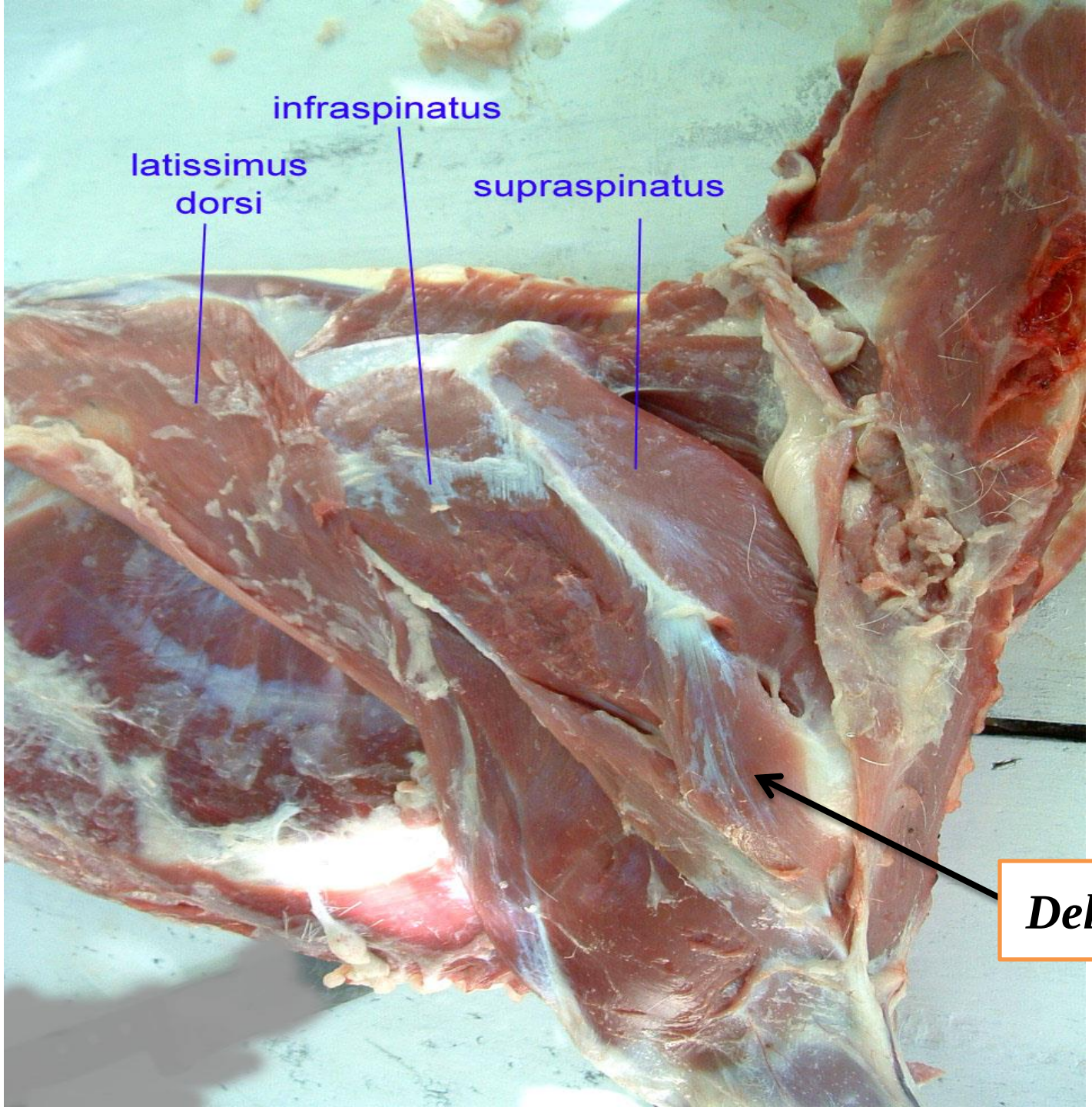
These muscles arise on the scapula and end on the arm.

They are grouped into two groups:

Lateral group

1. *Supraspinatus*

- *Location*: it occupies supraspinous fossa.
- *Origin*: supraspinous fossa, spine and cartilage of the scapula.
- *Insertion*: cranial part of the lesser and greater tuberosity of the humerus.
- *Action*: To extend and brace the shoulder joint.


infraspinatus
latissimus dorsi
supraspinatus
Deltoidus

2. *Infraspinatus*

Location: it occupies in the infraspinatus fossa

Origin: infraspinatus fossa just caudal and ventral to the spine of the scapula and scapular cartilage.

Insertion: Caudal part of greater tuberosity of the humerus.

Action: to abduct arm and rotate it laterally

3. *Deltoideus*

Origin: proximal and caudal border of scapula and along the length of the spine of the scapula.

Insertion: deltoid tuberosity.

Action: to flex the shoulder joint and abduct the arm.

Medial group

Subscapularis:

Origin: Deep surface of the scapula

Insertion: caudal eminence of the lesser tuberosity of the humerus.

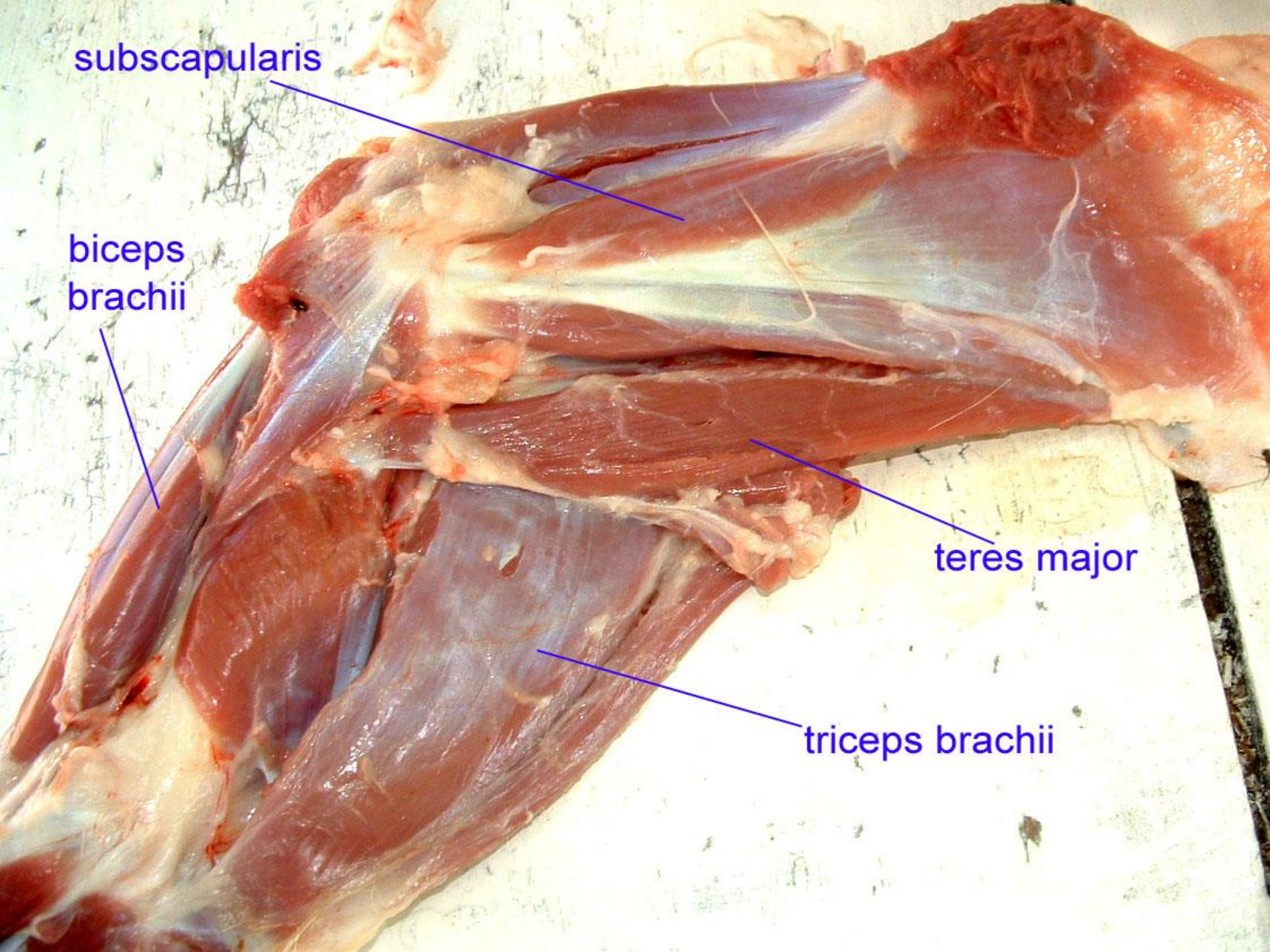
Action: braces medial shoulder joint, potential adductor of the humerus.

Coracobrachialis:

Origin: coracoid process of the scapula

Insertion: proximal shaft of the humerus

Action: to adduct the arm and to flex the shoulder joint.


subscapularis
biceps brachii
teres major
triceps brachii

Teres major

A flat wide muscle and lies chiefly on the medial face of *triceps brachi*.

Origin: dorsal part of the caudal scapula

Insertion: teres major tuberosity midway down humerus

Action-to flex the shoulder joint and adduct the arm.

C. Muscle of the arm

- It consists of five muscles which are grouped around the humerus.
- Some of these muscles are commonly examined for the presence of cysts of *tape worm*.

Biceps brachii

Location: lies on the cranial surface of the humerus.

Origin: supraglenoid tubercle.

Insertion: radial tuberosity and medial collateral ligament of elbow joint.

Action: to flex the elbow joint

Brachialis:

Location: it occupies musculospiral groove of the humerus.

Origin: the caudal surface of the proximal humerus.

Insertion: the medial border of the distal humerus.

Action: to flex the elbow joint???

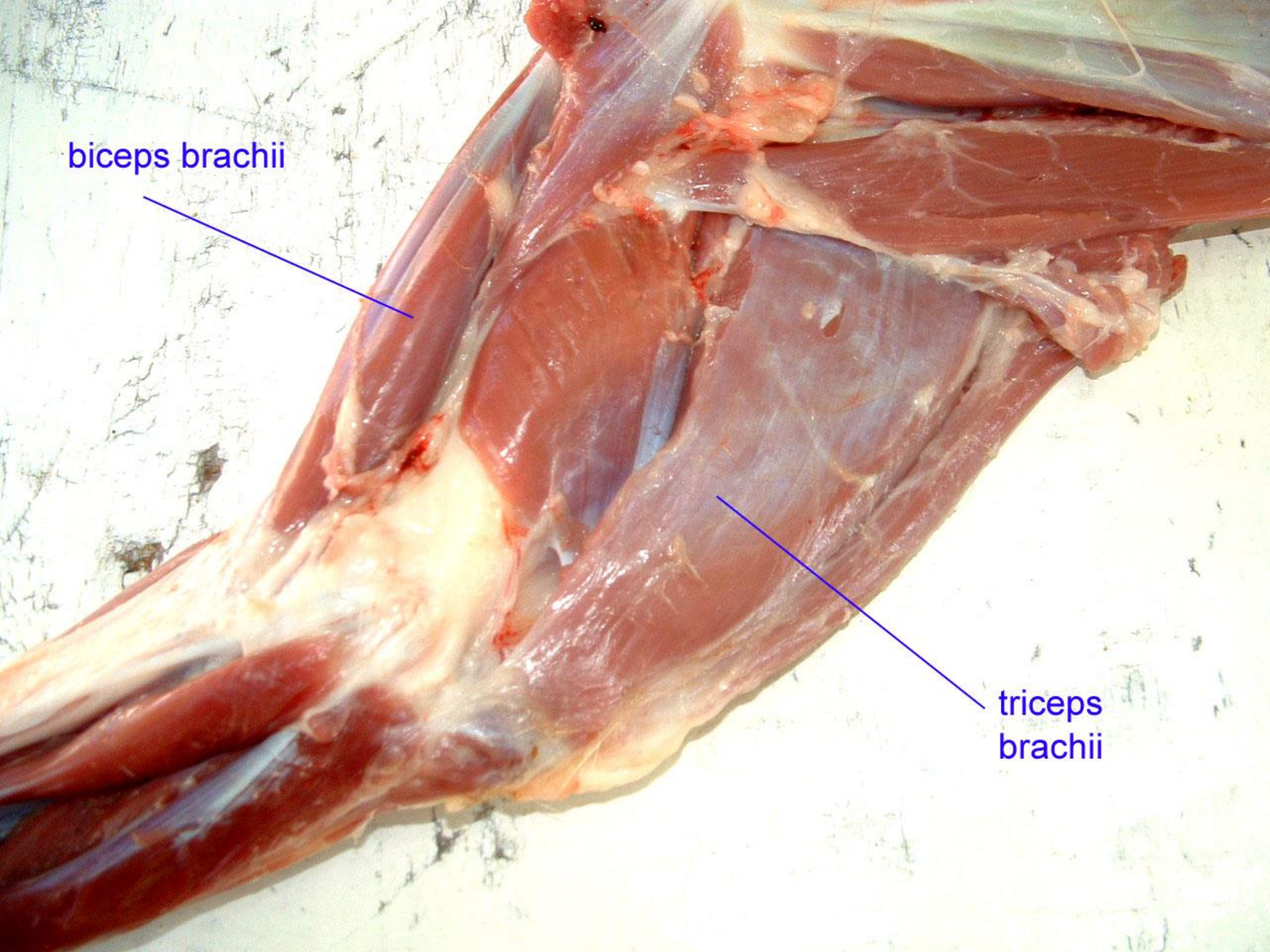
Tenser fasciae antebrachii

Location: is thin muscle which lies chiefly on the medial surface of the long head of the *triceps brachii*.

Origin: caudal border of the scapula.

Insertion: Olecranon and deep fascia of the forearm.

Action: to extend the elbow joint and tensor fascia of the forearm.


biceps brachii
triceps
brachii

Triceps brachii: together with the preceding muscle, constitutes the large muscular mass, which fill the angle of the caudal border of the scapula and humerus.

It has three heads:

a) Long head: is the largest and longest head, powerful thick triangular muscle which extends from the caudal border of the scapula to the olecranon.

Origin: the caudal border of the scapula

Insertion: the lateral and caudal part of olecranon tuber.

b) **Lateral head**:

Is a strong, quadrilateral muscle which lies on the lateral surfaces of the arm.

Origin: deltoid tuberosity and rough line which extends to the neck of the humerus.

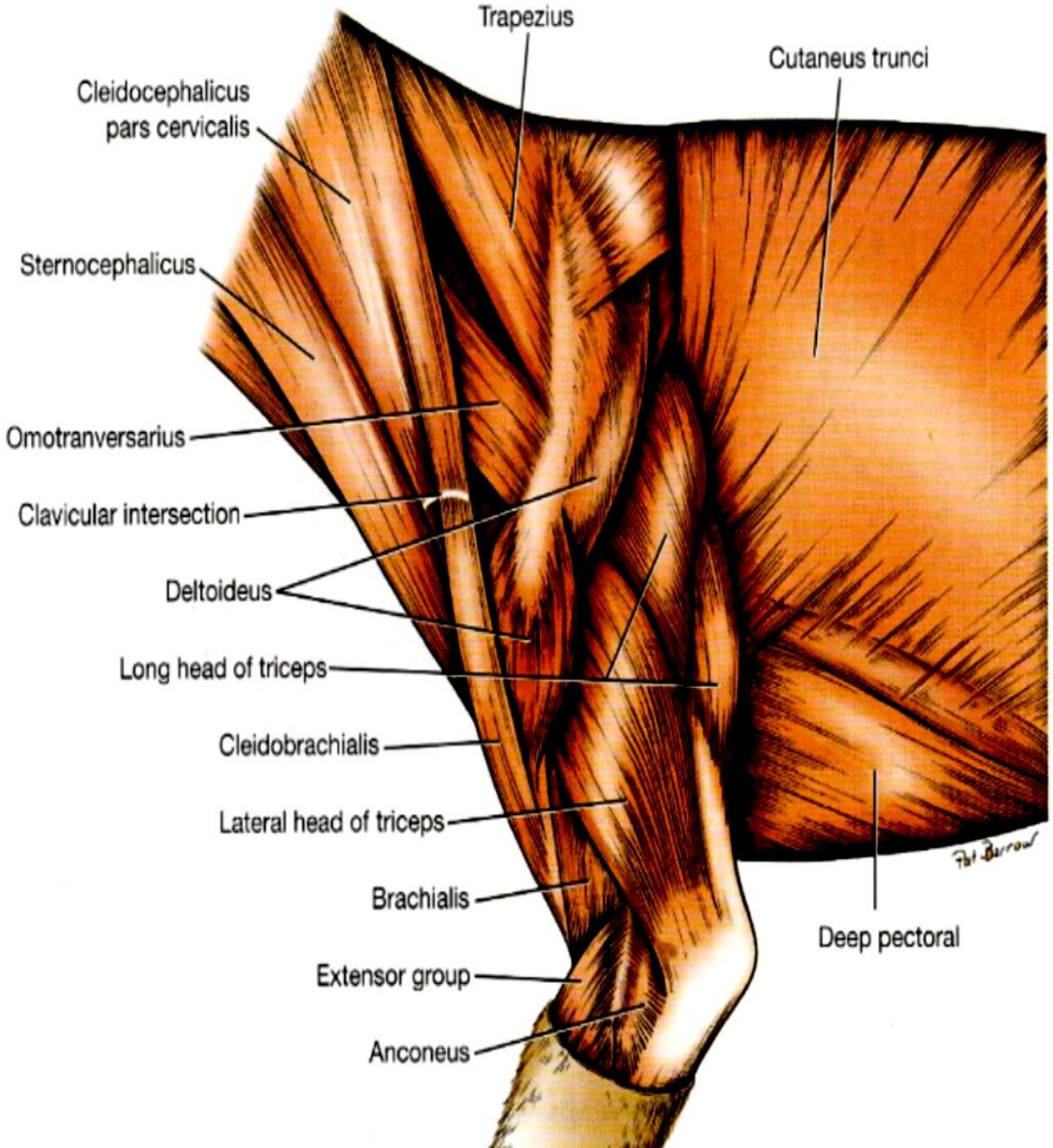
Insertion: Lateral surface of the olecranon.

c) **Medial head**: is the smallest of the three heads and lies on the medial surface of the arm.

Origin: the middle third of the humerus caudal and distal to the olecranon tuber.

Insertion: medial and cranial part of the olecranon tuber.

Action: of triceps brachii to extend the elbow joint.



- Cutaneus trunci m.

"skin under the trunk"

Anconeus: Is a small muscle which cover the olecranon fossa and is covered by *triceps brachii*

Origin: the lateral epicondyle of the humerus

Insertion: to the olecranon and proximal part of the ulna

Action: extend the elbow joint.

D. Muscles of the forearm and manus

- The forearm is covered on three sides by the muscles of this group, leaving the medial surface of the radius for the most part subcutaneous.
- Extensor of the carpus and digit lies on the cranial and lateral part while the flexor occupy the caudal surface.

A. Extensor Division:

- These are extensors of the carpus and flexors of the elbow.

1. Extensor carpi radialis(ECR): is the largest muscle of the group

Location: lies on the cranial surface of the radius

Origin: lateral epicondyle of the humerus.

Insertion: cranial aspect of proximal part of metacarpal.

Action: to extend and fix the carpal joint and to flex the elbow joint.

2. Extensor digitorum communis (EDC): It has two head: humeral (large) and smaller head.

Location: lies lateral to the ECR.

Origin: cranial aspect of the distal extremity of the humerus and lateral tuberosity of the proximal extremity of the radius.

Insertion: the extensor process of the dorsar phalanx and dorsal surface of proximal extremity of I and II phalanxes.

Action: to extend the digital and carpal joint and flex the elbow joint

***3. Extensor digitorum lateralis (EDL)*:** is much smaller and is situated caudally.

Origin: lateral collateral ligament of elbow, proximal radius & ulna

Insertion: proximal phalanx.

Action: to extend the digit and carpus.

B. Flexor division

They are flexor of the carpal joint and extensor of the elbow.

1. Flexor carpi radialis (FCR)

Location: lies on the medial surface of the forearm, caudal to the border of the radius.

Origin: medial epicondyle of the humerus

Insertion: palmeromedial aspect of proximal Metacarpus.

Action: to flex the carpal joint and extend the elbow.

2. Flexor carpi ulnaris (FCU):

Location: lies on the medial and caudal aspect of the forearm, partly under and partly caudal to the preceding muscle.

Origin: medial epicondyle of the humerus and medial surface and caudal border of olecranon

Insertion: proximal edge of the accessory carpal bone.

Action: to flex carpal joint and extend the elbow.

3. Ulnaris lateralis (UL or Extensor carpi ulnaris)

Morphologically it belongs to the extensor group.

Location: lies on the lateral face of the forearm caudal to *EDL*

Origin: lateral epicondyle of the humerus.

Insertion: lateral surface of the border of the accessory carpal bone and proximal extremity of metacarpal bone.

Action: to flex the carpal joint and to extend the elbow.

4. Flexor digitorum superficialis (FDS)

Location: in the middle of the flexor group between the FCU and FDP.

Origin: medial humeral epicondyle

Insertion: middle phalanx

Action: to flex the carpal joint and to extend the elbow.

5. Flexor digitorum profundus (FDP): is the largest of the flexor group.

Origin: medial humeral epicondyle, caudal radius, medial Olecranon.

Insertion: palmar surface of distal phalanx.

Location: lies on the caudal surface of the radius

Action: to flex the carpal joint and to extend the elbow.

7.2. Muscles of the Pelvic limb

- In most domestic mammals the muscles of pelvic limb are well developed and plays a dominant role in the forward propulsion of the animal.
- But in camel the musculature of pelvic limb is relatively slender as compared to the sturdy of development of the front limb and thus doesn't appear to play a major role in forward propulsion.
- The muscles of pelvic limb includes:

A. Sub lumbar muscles

B. Muscles of the hip and thigh

C. Muscles of the leg and foot

A. Sublumbar muscles

The important ones are the *iliacus* and *psoas* major which are **inserted** in the lesser trochanter of the femur.

Iliacus: located ventral to the ilium

Origin: ventral surface of the ilium

Action: to flex the hip joint and rotate the thigh.

Psoas major: located lateral to the ilium

Origin: ventral surface of the lumbar transverse processes

Action: to flex the hip joint and rotate the thigh.

- These two muscles form the *iliopsoas* and make up the **tenderloin**.

B. Muscles of the hip and thigh

These are grouped as lateral, cranial, and medial

a. Lateral group

1. Tensor fasciae latae

Location: cranial edge of the thigh.

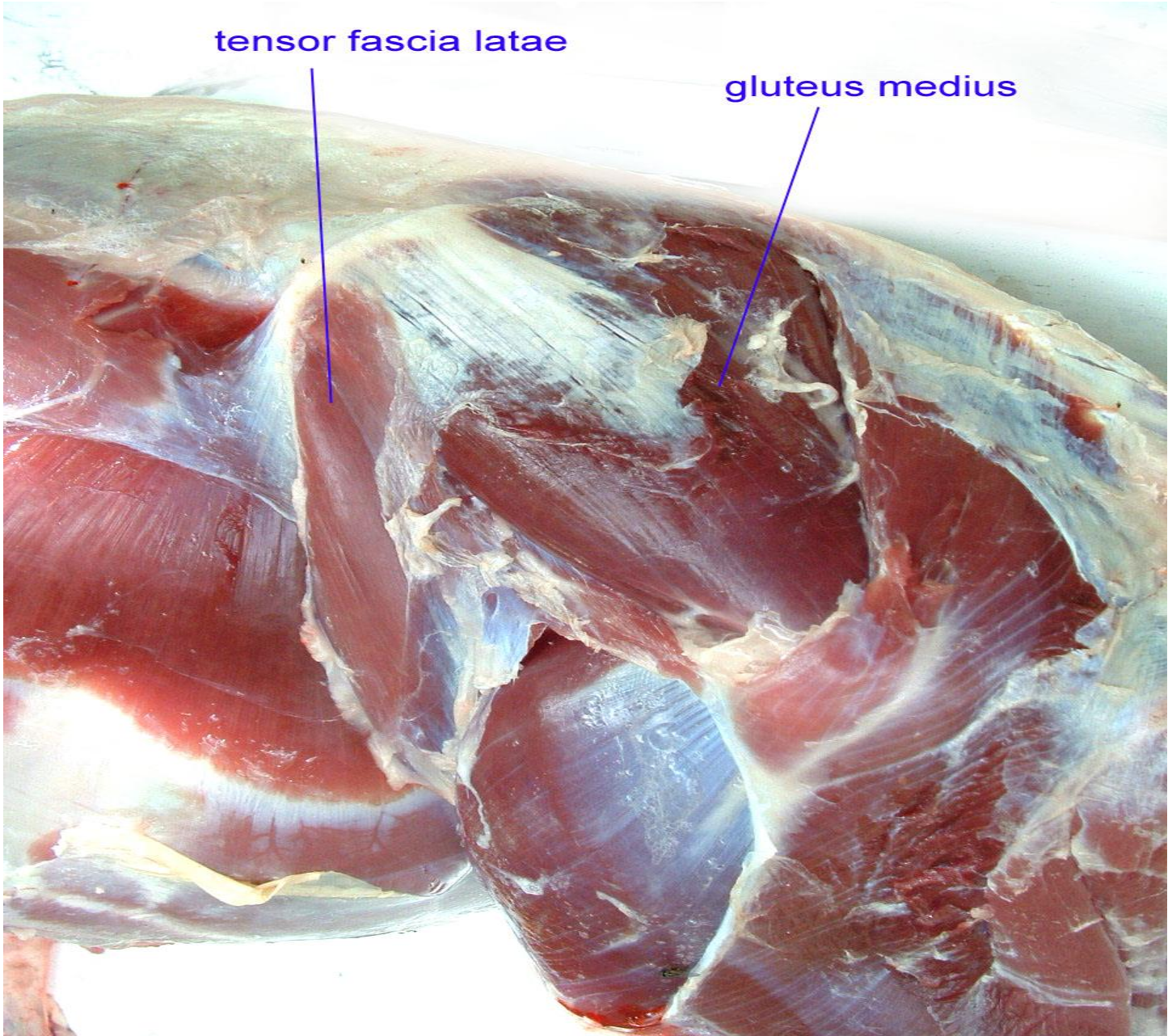
Origin: tuber coxae and gluteal fascia.

Insertion: patella and tibia.

Action: flex the hip joint and extend the stifle joint??.

2. Gluteus medius:

Location: it is the thigh fleshy muscle filling the space between the coxal tuber and greater trochanter of the femur.


tensor fascia latae
gluteus medius

Origin: Wing of ileum, tuber coxae, sacrum, broad sacrotuberal ligament.

Insertion: greater trochanter of the femur.

Action: extends the hip joint, adduct the limb and rotate the femur.

Relation: it is related to the ischiatic nerve with its deep face and also to the ilium.

❖The gluteal muscles are commonly used for **intra muscular injection** in large cattle.

3. Biceps femori (called ***gluteobiceps*** in ruminants)

- Lies caudal to and in part upon the gluteal medius.
- *Origin:* has two heads
  - Cranial superficial head - sacrotuberal ligament.
  - Caudal head - lateral aspect of ischial tuber.
- *Insertion*–the two muscle bellies unite at an aponeurosis attached to the stifle and crural fascia.
- This fascia then inserts on the patella, patellar ligament, and tibial tuberosity.

- A distal tendon of the muscle separates from the main muscle belly and passes under the adductor and along the *gastrocnemius*.
- It moves in front of the *calcaneal tendon* and combining with a tendon of the *semitendinous* muscle inserts on the *calcaneal tuberosity*.

Action—complex; the muscle is composed of many parts and has several point of insertion and acts on all joints of the limb except the digits.

- General action: to extend the limb (stifle, hip and hock joints) as in propelling the body, rearing or kicking and to abduct it.

- Cranial part with femur and patella extend the stifle and the hip joint.
- Middle part (inserted to the cranial border of tibia and lateral patellar ligament)-extend the hip joint and together with semitendenious flex the stifle .
- The caudal part by virtue of its attachment to the *calcaneal tuber* assist extending the hook.

4. Semitendinosus

Location: on the caudal aspect of the rump between the *biceps femori* and *semimembranosus*

Origin: Sacrum and caudal vertebrae, sacrosciatic ligament, ischial tuber.

Insertion: cranial border of the tibia and calcaneal tuber.

Action: to extend the hip and hock joints, to flex stifle joint and rotate the leg medially.


biceps femoris
semitendinosus
semimembranosus

5. Semimembranosus:

Location: caudal aspect of the rump

Origin: Caudal vertebrae, sacrosciatic ligament, ischial tuber.

Insertion: medial epicondyle of the femur and medial margin of the tibia.

Action: to extend the hip joint and adduct the limb.

❖*Biceps femoris, semitendnosus, and semimembranosus* together constitute the **hamstring muscle**; this with middle gluteus are chief **extensor of the hip joint**.

b. Cranial group

Quadriceps femoris*:* is the largest extensor of the stifle joint and has four heads.

The heads are rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis.

Rectus femoris: is the long head and originated from the **ilium** above the acetabulum.

Vastus medialis: is located on the medial surface of the thigh and originated from the **femur and os coxae**

Vastus intermedius: located on the cranial, medial and lateral surface of the thigh and originated from the **femur and os coxae**

Vastus lateralis: is the lateral portion of the thigh and originated from the **femur and os coxae**

Insertion: All of the qaudriceps femoris insert on the **patella** (kneecap)

Action: to extend the stifle joint.

c. Medial group:

Sartorius: is strap like muscle coursing across the craniomedial surface of the thigh to the stifle.

Origin: the body of the ilium and tendon of the *psoas major*.

Insertion: proximal part of the tibia and medial patellar ligament.

Action: flex the hip joint and abduct the limb.

Gracilis: is the broad flat muscle.

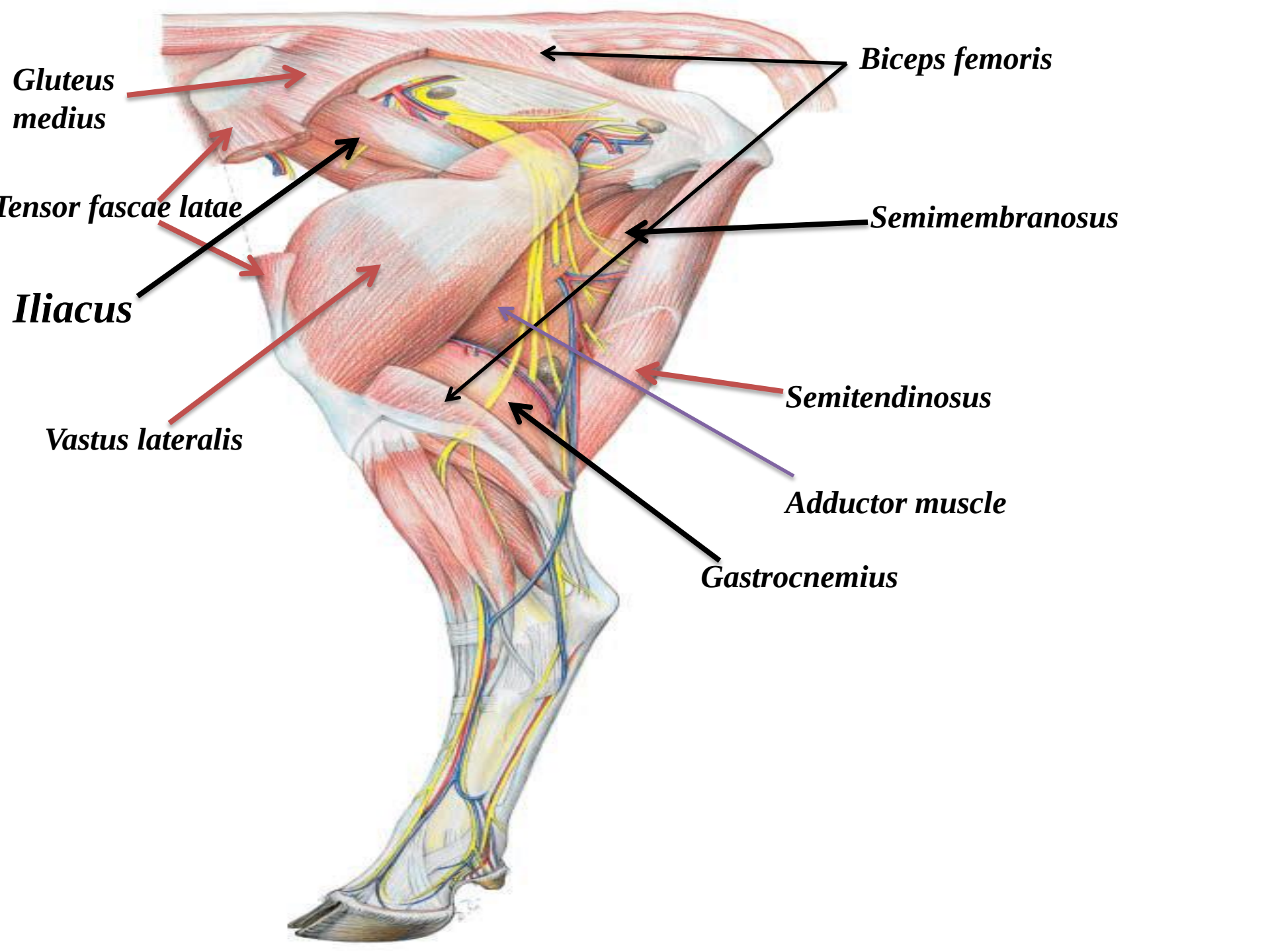
Location: superficial over the caudal portion of the medial aspect of the thigh.

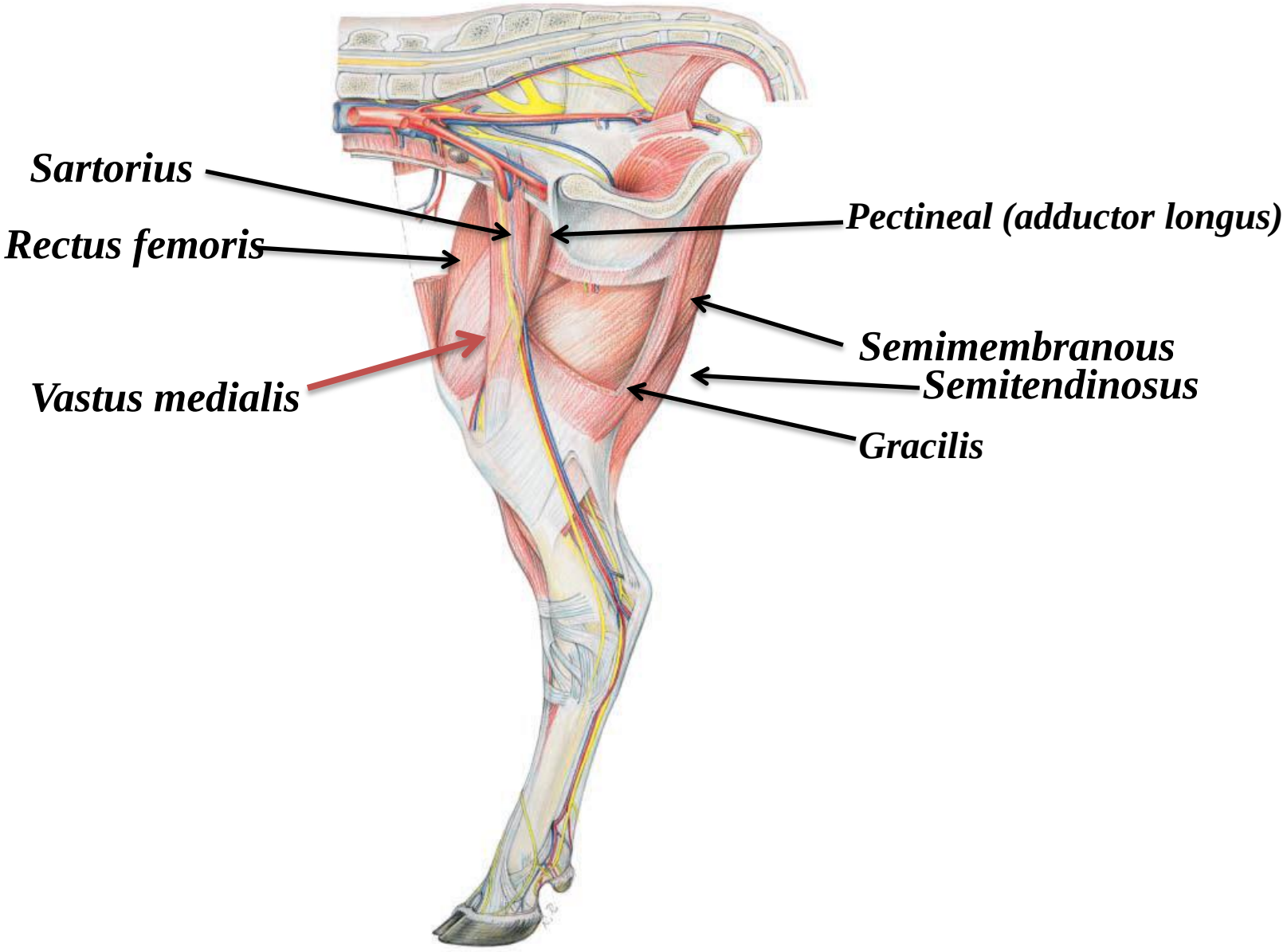
Origin: pubis, pubic symphysis and prepubic tendon

Insertion: medial patellar ligament and tibia

Action: flex the stifle, adduct the thigh and extend the hock joint.

- The ***hamstring*** and the ***medial groups*** of muscle are commonly used for intramuscular injections in calves, small ruminants, dog and cats.


Gluteus medius
Tensor fascae latae
Iliacus
Vastus lateralis
Biceps femoris
Semimembranosus
Semitendinosus
Adductor muscle
Gastrocnemius


Sartorius
Rectus femoris
Vastus medialis
Pectineal (adductor longus)
Semimembranous
Semitendinosus
Gracilis

***Pectineal* (long adductor** is fused to the pectineal**)**

- Fusiform and extends from the cranial border of the pubis to the middle of the medial border of the femur.
- *Origin*- a fleshy origin from the iliopubic eminence and a tendinous origin from the prepubic tendon.
- *Insertion*–via a tendinous attachment to the popliteal surface of the femur near the nutrient foramen.
- *Action*-to adduct the limb and to flex the hip joint

Adductor Muscles

- The **greater adductor muscle** originates from the pelvic symphysis and prepubic tendon.
- Inserts on the popliteal fossa and the lateral supracondylar tuberosity.
- The **short adductor** originates on the pubic tubercle and inserts on the caudal aspect of the femur.
- The **long adductor** is fused to the pectineal. (This is remains unfused in cats)

C. Muscles of the leg and foot

They consist of two groups of muscles: dorsolateral (craniolateral) and plantar group.

1. Dorsolateral group:

a. Tibialis cranialis:

Origin: lateral aspect of the proximal tibia

Insertion: Proximal metatarsus

Action: flex the hock(tarsal) joint.

b. Extensor digitorum longus:

Location: craniolateral surface of the leg covered by the fibularis tertius

Origin: femur

Insertion: extensor process of the distal phalanx.

Action: extend the digit and flex the hock

c. Extensor digitorium lateralis:

Location: lateral surface of the leg

Origin: lateral collateral ligament

Insertion: middle phalanx or metatarsus in horse

Action: extend the fourth digit.

d. Fibularis (peroneus) longus: is absent in horse

Location: on the most superficial position of the lateral surface of the leg.

Origin: lateral condyle of the tibia

Insertion: tarsal bones

Action: flex the hock joint

***e. Fibularis (peroneus) tertius**:* is absent in carnivores

Origin: extensor fossa of the femur (in common with the extensor digitorum longus)

Insertion: base of the metatarsal bones and some tarsal bones

Action: flex the tarsal joint and extend the genual (stifle) joint.

2. Plantar group

***a. Gastrocnemius**:* forms the fleshy portion of the caudal aspect of the leg and consists of medial and lateral heads.

Origin: lateral and medial epicondyles of the femur.

Insertion: Calcaneal tuber by a strong tendon, **Achilles tendon** in common with flexor digitorum superficialis.

Action: extend the hock and flex the stifle

b. Soleus: is absent in dog, but present in cat and other domestic animals.

Origin: head of the fibula (lateral femur in pig).

Insertion: tendon of the lateral head of the *gastoenemius* muscle.

Action: assist the *gastroenemius* muscle in the extension of the hock (tarsal) joint.

- The *Soleus* and the two heads of the *gastroenemius* collectively termed the ***triceps surae***.

c. Flexor digitorum superficialis

Origin: supracondyloid fossa or lateral supracondyloid tuberosity

Insertion: calcanceal tuber of calcaneus and middle phalanx.

Action: flexes the digit and extends the hock

d. Flexor digitorum profundus

It consists of three heads in ungulates and two heads in carnivores.

They are

- tibialis caudalis (superficial head),
- lateral digital flexor (deep head) and
- medial digital flexor (medial head).

Origin: caudal aspect of the tibia

Insertion: distal phalanx

Action: flex the digital joints and extend the hock joint.

Clinically Important Muscle

Abdominal Incision

- Incision through the flank or, more generally, through any part of the abdominal wall (laparatomy) is common for many things like:
  - Surgical treatment of abdominal organ disorder and diseases.
  - Correction of abdominal organs displacement.
  - For exploratory laparatomy etc..

Dorsal part of abdominal (flank) incision

- ✓ Skin
- ✓ Subcutaneous tissue (cutaneous muscle and fascia)
- ✓ External oblique abdominal muscle
- ✓ Internal oblique abdominal muscle
- ✓ Transverse abdominal muscle
- ✓ Peritoneum

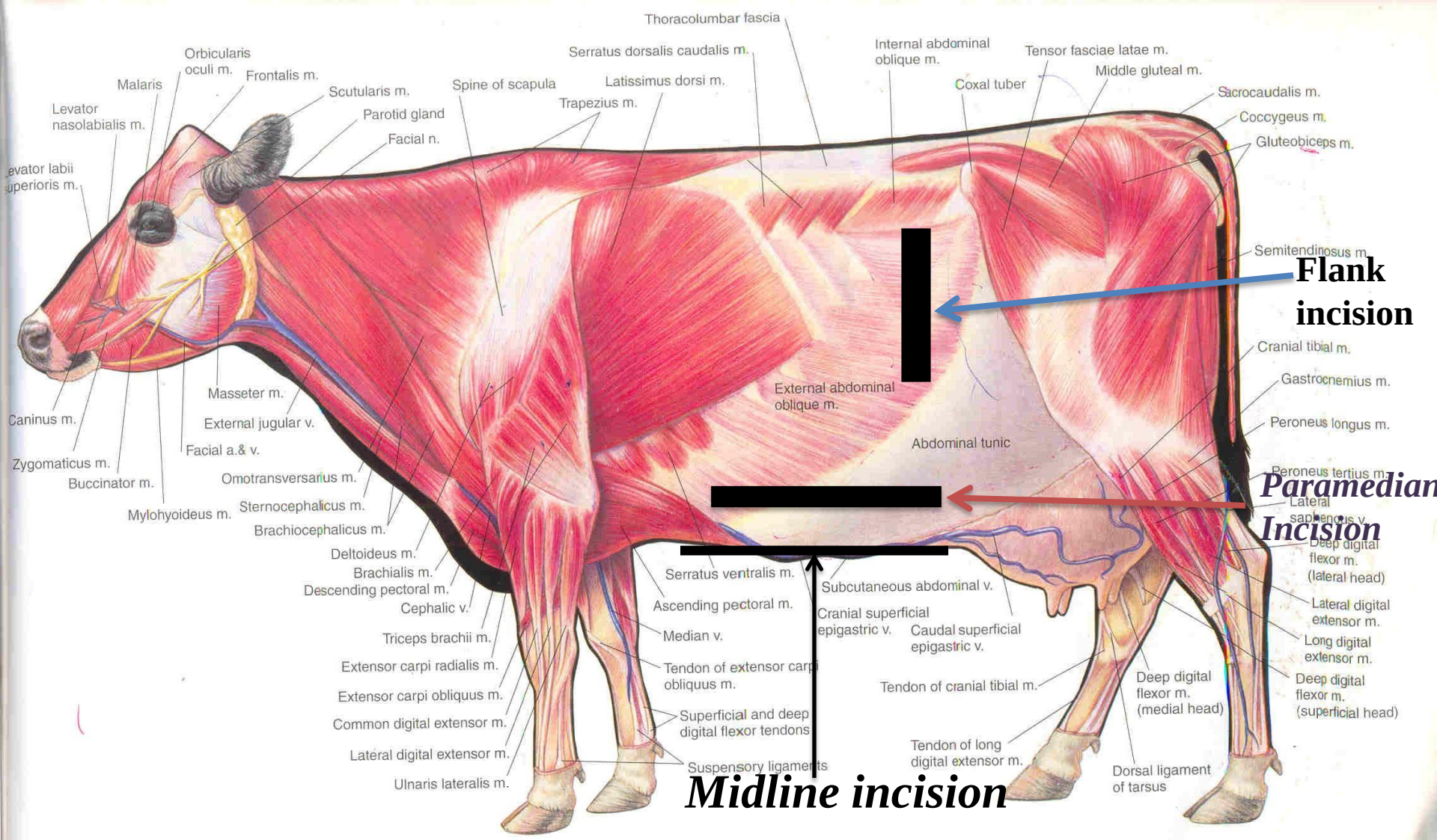


PLATE 2.6 Superficial muscles and veins of the cow. Left lateral view.
m = muscle, v = vein, a = artery, n = nerve

Paramedian Incision

- ✓ Skin
- ✓ Subcutaneous tissue
- ✓ Rectus abdominis muscle
- ✓ Transverse fascia of upper abdominal muscles
- ✓ Peritonium

Midline incision

- ✓ Skin
- ✓ Subcutaneous tissue
- ✓ Linea alba (tendonous sheath) of external and internal oblique and transverse abdominal muscle
- ✓ Peritonium

Intramuscular Injection Sites

- Because skeletal muscle have large blood supplies, drug injected into them are absorbed into the blood stream and quickly carried off to the rest of the body.
- This method of drug administration called an **Intramuscular** (**IM**) **injection** and it is commonly used when rapid drug effect is desired.
- It is the fastest way next to intravenous (IV) injection
- In theory we should be able to use any skeletal muscle for an IM injection
- In practice however, it may not possible all muscles due to:
  - ✓ some muscles are either too small or too thin to allow such an injection;
  - ✓ Some others are also have prominent structures nearby, such as nerves that could be damaged by the injection.

To be useful for an intramuscular injection a given muscle must be

- ✓ Fairly large
- ✓ Easily accessible
- ✓ Have sufficient belly into which drug can be deposited
- ✓ Not thin and directly on nerve plexus

The following are some common IM injection sites used in domestic animals.

In dog and cat

Pelvic limbs

- ✓ *Gluteal muscle*
- ✓ *Quadriceps femoris muscle*
- ✓ *Gastrocnemius muscle* (most commonly preferred site)
- ✓ *Hamstring muscle* with medial group (most commonly preferred site)

Thoracic limbs

- ✓ Triceps brachi muscle

In Cattle, Goats and Sheep

Pelvic limb

- ✓ *Gluteal muscles* (**most commonly preferred site in adult cattle**)
- ✓ *Hamstring group and medial group* together (**most commonly preferred site in shoat and calves**)

Thoracic limb

- ✓ *Triceps brachii muscle*

Neck

- ✓ *Lateral cervical muscles*

In Horses

Pelvic limb

- ✓ *Gluteal muscles*
- ✓ *Hamstring group*

Thoracic limb

✓ *Triceps brachii muscle*

Neck

✓ *Lateral cervical muscles* (**commonly preferred site**)

Chest

✓ *Pectorialis muscle*

Pig

Pelvic limb

✓ *Semitendinosus muscle*

Neck

✓ *Brachiocephalic muscle*

✓ *Trapezius muscle*

Coelomic cavity and Serous membranes

Definition: Coelomic cavities are cavities that enclose the visceral organs of the body.

- The cavity within the body of all animals higher than certain primitive worms, formed by the splitting of the embryonic mesoderm into two layers.

- Serous membranes are membranes that line the coelomic cavities and cover the visceral organs.

- Most of the internal organs are placed in the body cavities and are lined by serous membranes.

Development of Coelomic cavities

- The intra-embryonic mesoderm appears at an early stage and becomes organized in paraxial, intermediate and lateral plate mesoderm.
- The coelomic cavities develop from the lateral plate mesoderm.
- The mesodermic layer forming part of the somatopleure constitute the parietal serous membrane while the layer forming part of the splanchnopleure constitute the visceral serous membrane.
- The cavity formed between these two layers is the celomic cavity.

Importance studying coelomic cavities and serous membranes:

- Important during surgical procedures involving these areas, including abdominocentesis and thoracocentesis.
- During clinical examination of the thoracic and abdominal area.

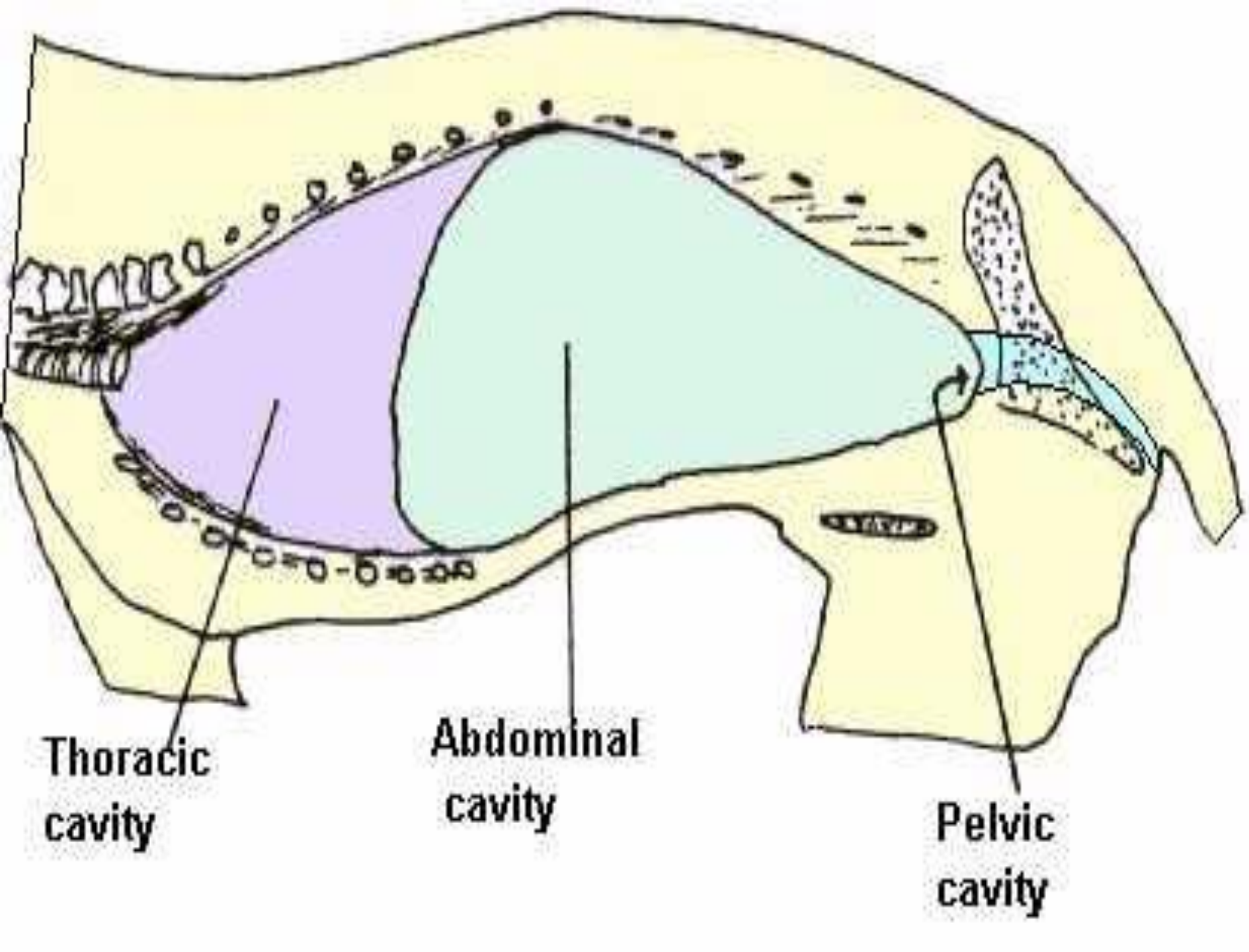
- The body cavity is divided into two by the diaphragm
  - ✓ Thoracic cavity
  - ✓ Abdominal cavity
- The organs and the walls of the cavities are covered by a thin moist **transparent serous membrane**.
- The lining of the walls of the cavities is called **parietal serous membrane**.
- Layer on the organs of the thoracic and abdominal cavities is called **visceral serous membrane**.
- The parietal and visceral parts are connected by **intermediate serous membrane** named for the organs to which they are attached.

- Example, mesentery, mesocolon, mesovarium, and pulmonary ligament.
- Its intermediate and visceral parts, provide
  - ✓elasticity
  - ✓adaptable suspension mechanism, and
  - ✓pathway for the blood and lymph vessels and nerves.
- The free surface is smooth and lubricated by a small amount of serous fluid,
- Hence, the viscera can glide on the wall of the cavities or on one another with at least possible amount of friction.

BODY CAVITIES

1. Thoracic cavity

- It is the second largest cavity and truncated cone in its form.
- It has a conical outline with a base cut of oblique.
- Dorsal wall or roof of the cavity formed by the thoracic vertebrae, and the ligaments and muscles.
- The lateral walls are formed by the ribs and the muscles in connection, and
- The ventral wall or the floor formed by sternum.
- While the caudal wall is formed by the diaphragm.


Thoracic cavity
Abdominal cavity
Pelvic cavity

A longitudinal septum or the mediastinum extends from the dorsal wall to the ventrocaudal wall.

Divides the thoracic cavity into two lateral chambers

- ✓Right and left pleural cavities which contain right and left lungs resp.

Mediastinum

- Upper portion filled with blood vessels, trachea, esophagus, and thymus
- Lower portion contains **pericardial cavity**
- The **heart** is located within the pericardial cavity

The cranial aperture or inlet:

- Is relatively small, narrow and oval in shape.
- It is bounded dorsally by the first thoracic vertebra, laterally by the first pair of rib and ventrally by the presternum of the sternum.

It is occupied by the:

- Longus colli muscle, trachea, esophagus, visceral nerves and lymph nodes associated with the neck region.

Abdominal cavity

- The largest cavity
- Separated from the thoracic cavity by the **diaphragm** and is continuous caudally with the pelvic cavity.
- The line of demarcation between the abdominal and the pelvic cavity is known as the **terminal line** or **brim of the pelvis**.
- This line is formed by
  - ✓base of sacrum dorsally,
  - ✓the arcuate (iliopectineal) lines laterally and
  - ✓the cranial border of the pubic bones ventrally.
- The lumbar vertebrae, the lumbar muscle and the lumbar part of the diaphragm form the dorsal wall of

- The lateral walls are formed by
  - ✓ the oblique and transverse abdominal muscle,
  - ✓ the abdominal fascia,
  - ✓ the cranial parts of the ilia & iliac muscles,
  - ✓ the cartilage of the asternal ribs and the parts of the caudal ribs caudal to the attachment of the diaphragm.
- The ventral wall or floor is made up of
  - ✓ two recti muscle,
  - ✓ the aponeurosis of the oblique and transverse muscles,
  - ✓ the abdominal fascia and the xiphoid cartilage.
- The cranial wall is formed by the diaphragm and is deeply concave greatly increasing the size of the abdomen at the expense of the thorax.

- Five apertures pierce the abdominal wall in the adult animal.
  - These are the three foramina of the diaphragm and the two inguinal canals.

Inguinal canals:

- ✓ oblique passage through the lower abdominal wall;
- ✓ in males it is the passage through which the testes descend into the scrotum and it contains the spermatic cord;
- ✓ in females it transmits the round ligament of the uterus,

- In the fetus there is also umbilical opening.
- The cavity contains the great part of the different internal organs.
- The flank is part of the lateral wall which is formed only of soft structures.
- The triangular depression on its dorsal part is termed the **paralumbar fossa**.

Pelvic cavity

- The pelvis is the caudal part of the trunk
  - ✓encloses the pelvic organs
  - ✓communicates cranially with the abdominal cavity
  - ✓demarcated by the terminal line.
- The dorsal wall of the pelvic cavity is formed by sacrum & first few caudal vertebrae.
- The lateral walls of are formed by the parts of the iliac and sacrotuberal ligaments.
- The ventral wall or floor of the pelvis is formed by the pubic and ischial bones.

- The boundary of the pelvic outlet is formed by
  - ✓the third caudal vertebra dorsally,
  - ✓the ischial arch ventrally and
  - ✓the semimembranous muscle laterally.
- Within pelvic bones, pelvic cavity contains:
  - ✓the rectum,
  - ✓parts of the internal genitalia,
  - ✓urinary organs,
  - ✓muscles,
  - ✓vessels and nerves.

Serous membranes

The pleura

Lining of the thoracic cavity and the surface of the thoracic organs.

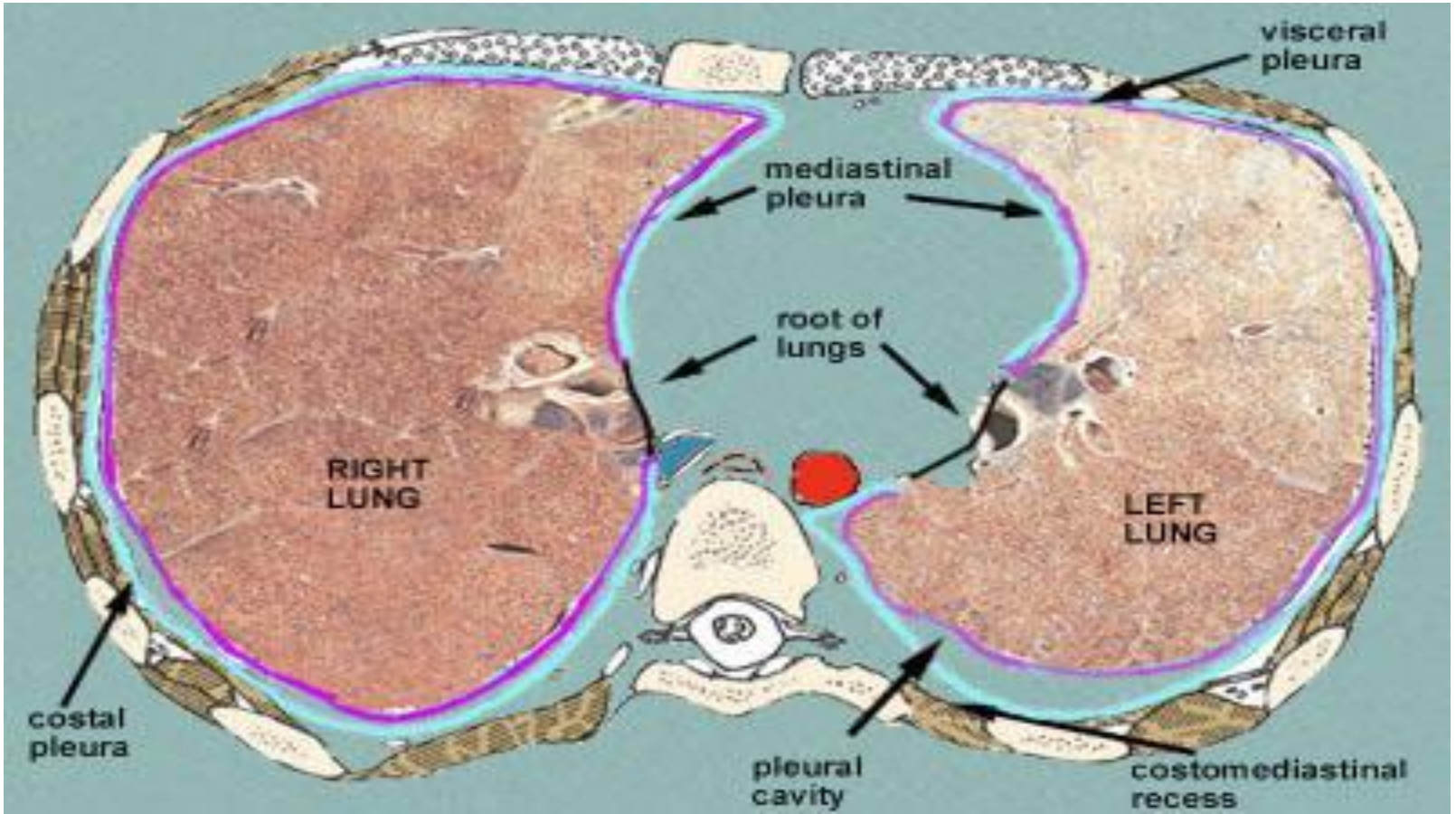
It is divided into two parts. These are:

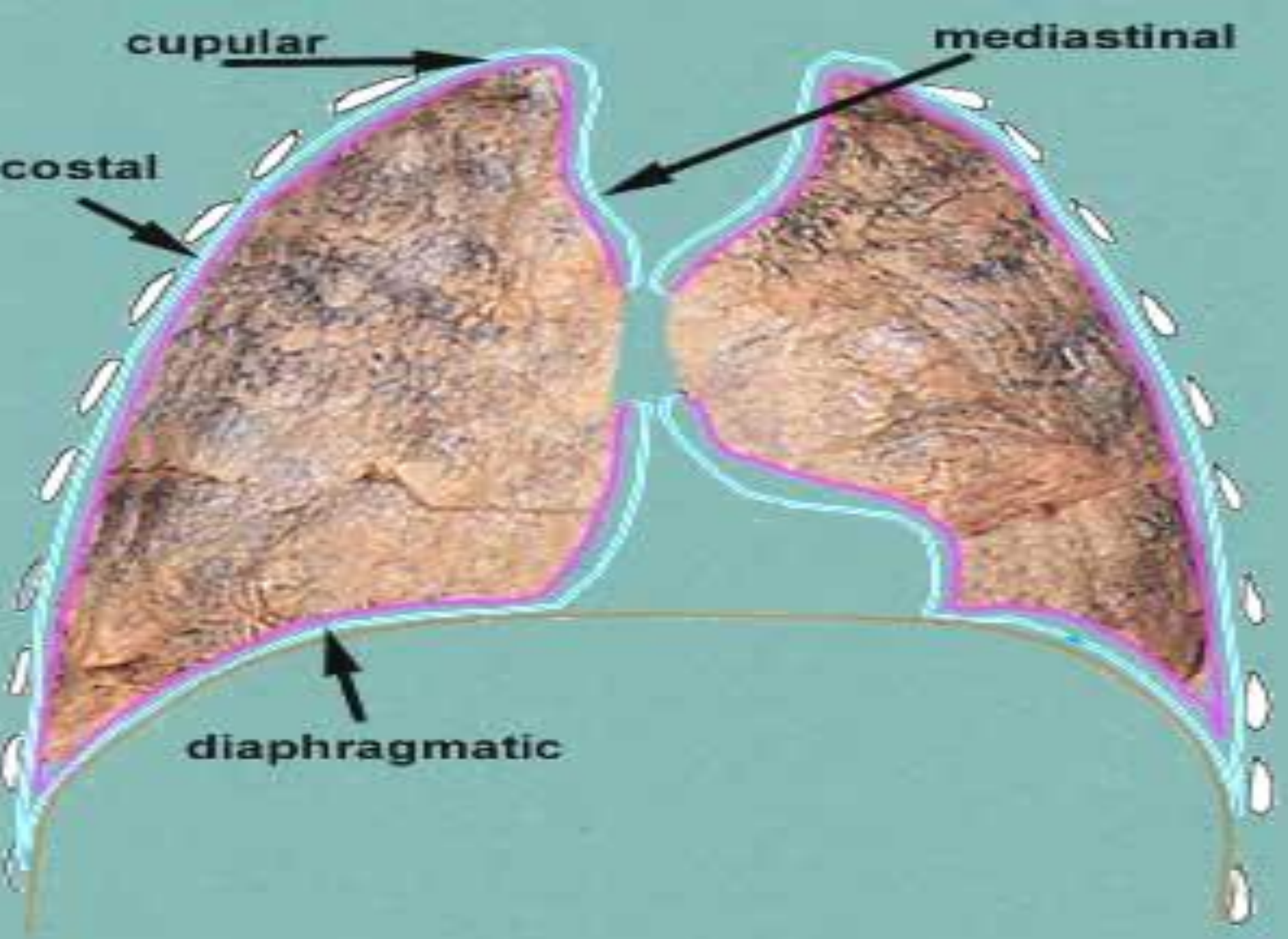
Visceral pleura: Is pleura which lines the surface of the lung.

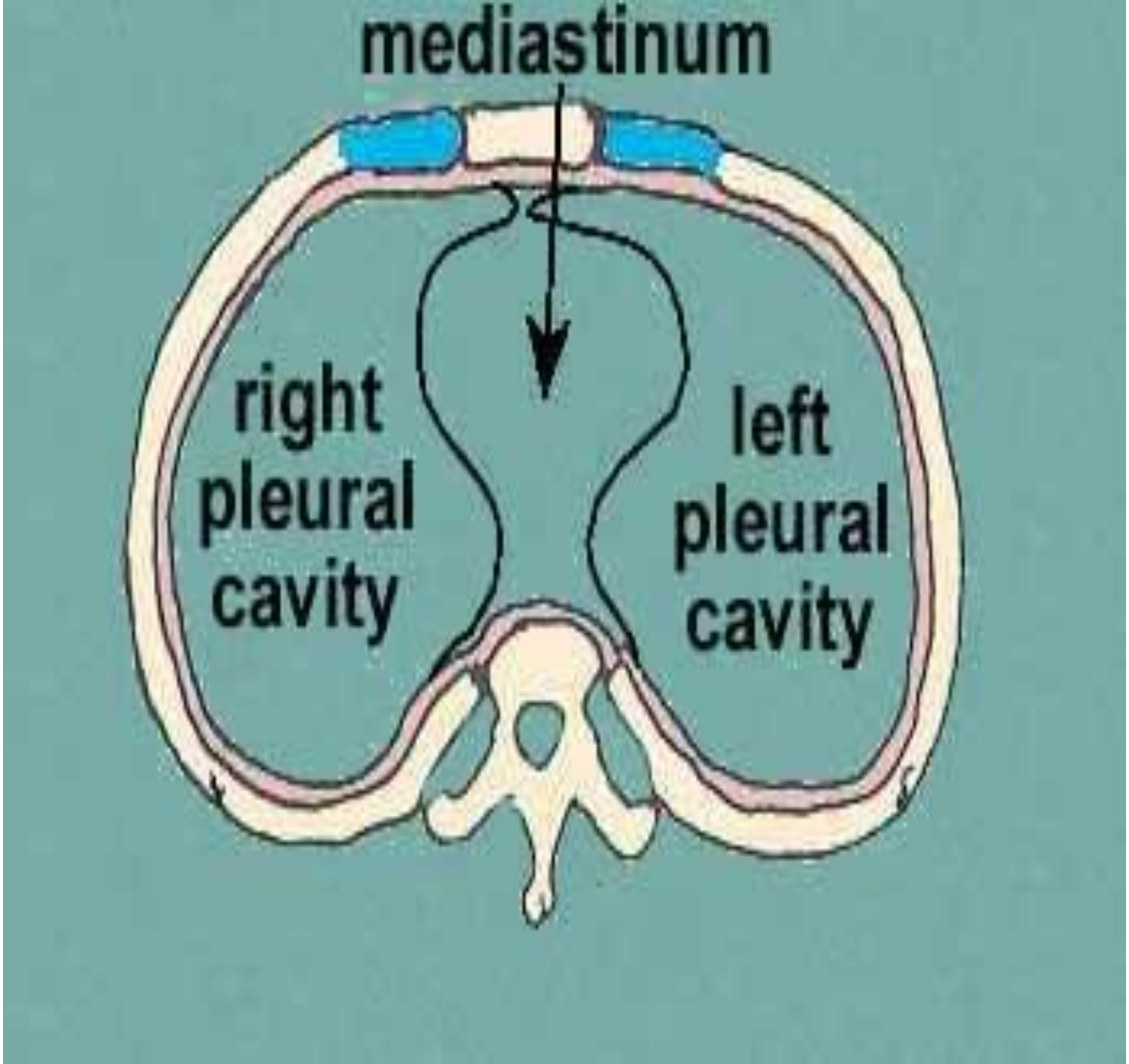
Parietal pleura: includes all the pleura, which are not on the surface of the lung.

- It consists of
  - ✓mediastinum pleura which is, pleura on the mediastinum and on the organs in the mediastinum,
  - ✓costal pleura is the pleura which line the thoracic wall and

- The parietal and the pulmonary pleura are arranged as closed invaginated sac and form the pleural cavity, which contains small amount of pleural fluid.
- The space between the right and left pleural sacs forms the mediastinum.




cupular
mediastinal
costal
diaphragmatic


mediastinum
right pleural cavity
left pleural cavity

Pericardium

- It is the serous membrane that covers the heart.
- Form a separate chamber between the two pleural cavities.
- It is placed asymmetrically with in the thorax.
- The largest part laying to the left of the median plane.
- It is divided into two as visceral pericardium and parietal pericardium.
- Visceral pericardium is the membrane, which lines on the surface of the heart.

- Parietal pericardium is the external membrane covering the visceral pericardium and is located b/n the left and right membranes of the pleura.
- The two layers of the pericardium form a closed sac, the pericardial cavity, which contains a small amount of clear serous fluid, the **liquor pericardii**.

The peritoneum

- It is a thin serous membrane
- Lines the abdominal cavity and partly the pelvic cavity.
- Covers to a greater or lesser extent, the viscera contained therein.
- In the male it is a completely closed sac but in the female, it has two small openings.
- The abdominal orifices of the uterine tubes-at their outer ends communicate with the uterus.
- The free surface of the membrane has a glistening appearance & is very smooth.
- This is due to the fact that this surface is formed by a layer of flat mesothelial cells and is moistened by the peritoneal fluid.

Omentum:

- It is a fold of serous membrane attached to the stomach.
- There are lesser and greater omenta, which pass from the dorsal abdominal wall to the greater curvature of the stomach and spleen.

Mesentery: It is the fold, which attaches the jejunum and ileum to the dorsal abdominal wall.

Mesocolon: attaches the colon with the parietal layer

Ligaments: are fold which pass between viscera other than parts of the digestive tube or connect them with the abdominal wall like the broad ligament of the uterus.

- Cranial part of the broad ligament includes *mesoovarium*, *mesosalpinx* and *mesometrium*

- The pelvic peritoneum is continuous cranially with that of the abdomen.
- Pelvic cavity is covered by the pelvic fascia and some part of it by peritoneum
- It lines the cavity for a variable distance caudally and is then reflected on to the viscera.
- We may therefore distinguish a cranial peritoneum and a caudal retroperitoneal part of the cavity.
- If the rectum is raised it will be seen that the peritoneum passes from its ventral surface and forms a transverse fold which lies between the rectum and the urinary bladder forming the genital fold.
- The genital fold is enlarged so as to enclose the uterus and small part of the vagina.

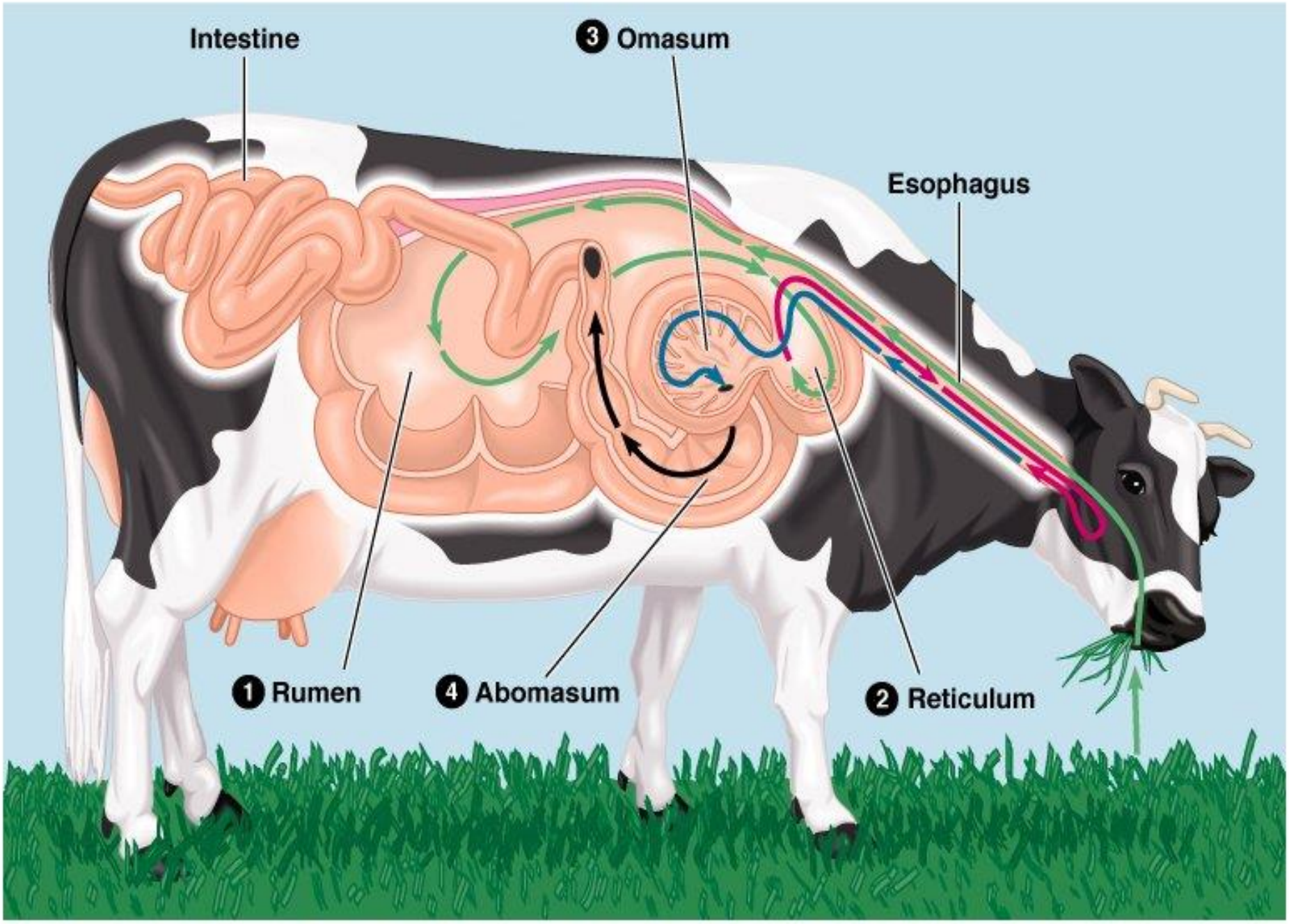
Vaginal tunics

- The cavity of the vaginal (inguinal) process begins at the vaginal (inguinal) ring and extends into the scrotum around the spermatic cord and testis.
- Connecting vaginal tunic forms: *mesorchium* and *mesoductus deferens*

Digestive system

Digestive system

- **Definition:** Is a musculomembranous tube of the body which consists of the organs directly concerned with digestion, absorption and expulsion of undigested portion of the food.
- Is continuous with the external skin and extends from the mouth to the anus.
- Most parts are lie caudal to diaphragm lie within the abdominal and pelvic cavities.
- They are invested with a simple squamous epithelium that is also called a ***mesothelium or serosa.***



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- Within these abdominal cavities, the ***serosa*** is identified as ***peritoneum.***
  - ✓where it lies directly on the organ, it is called ***visceral peritoneum***, and
  - ✓where it invests the abdominal wall, it is ***parietal peritoneum***
- Parietal and visceral peritoneum are continuous with one another through reflections of the peritonium (intermediate peritonium) that attach the organs to the body wall.
- **The organs of digestive system are conveniently grouped under two heads**:
  1) the alimentary canal
  2) the accessory organs

- **The alimentary canal** is a tube that extends from the lips to the anus.
- It has a complete lining of mucous membrane, external to which is an almost continuous muscular coat.
- The abdominal portion of the tube is largely covered with a serous membrane- the **visceral peritoneum**.
- The canal consists of the following consecutive segments:

1. Mouth
2. Pharynx
3. Oesophagus
4. Stomach (gladular and fore stomach)
5. Small intestine
6. Large intestine

Histologically the walls of tube has comprise four layers; from internal to external:

- ✓Mucosa layer
- ✓Submucosa layer
- ✓Muscularis layer and
- ✓Serosa (visceral peritonium)

- ❑**The accessory organs** are the teeth, tongue, salivary glands, liver, and pancreases.

- ➢Embryologically:
  - ✓ Oral cavity–from ectoderm
  - ✓The muscle and connective tissue support the epithelium are mesoderm
  - ✓The rest digestive canals and the accessory organs– from endoderm

Function of Digestive tract

- Its primary functions are
  - ✓Prehension,
  - ✓Mastication,
  - ✓Digestion and absorption of food and
  - ✓Elimination of solid wastes
- The digestive system reduces the nutritious constituents of the food to molecular compounds that are small enough to be absorbed and used for energy and for building other compounds for incorporation into body tissues.

Importance of studying digestive system

- Understanding of the process of digestion and food utilization.
- In the diagnosis and treatment of the disease of the digestive organs and/or system

1. **Mouth (*os, oris*)**

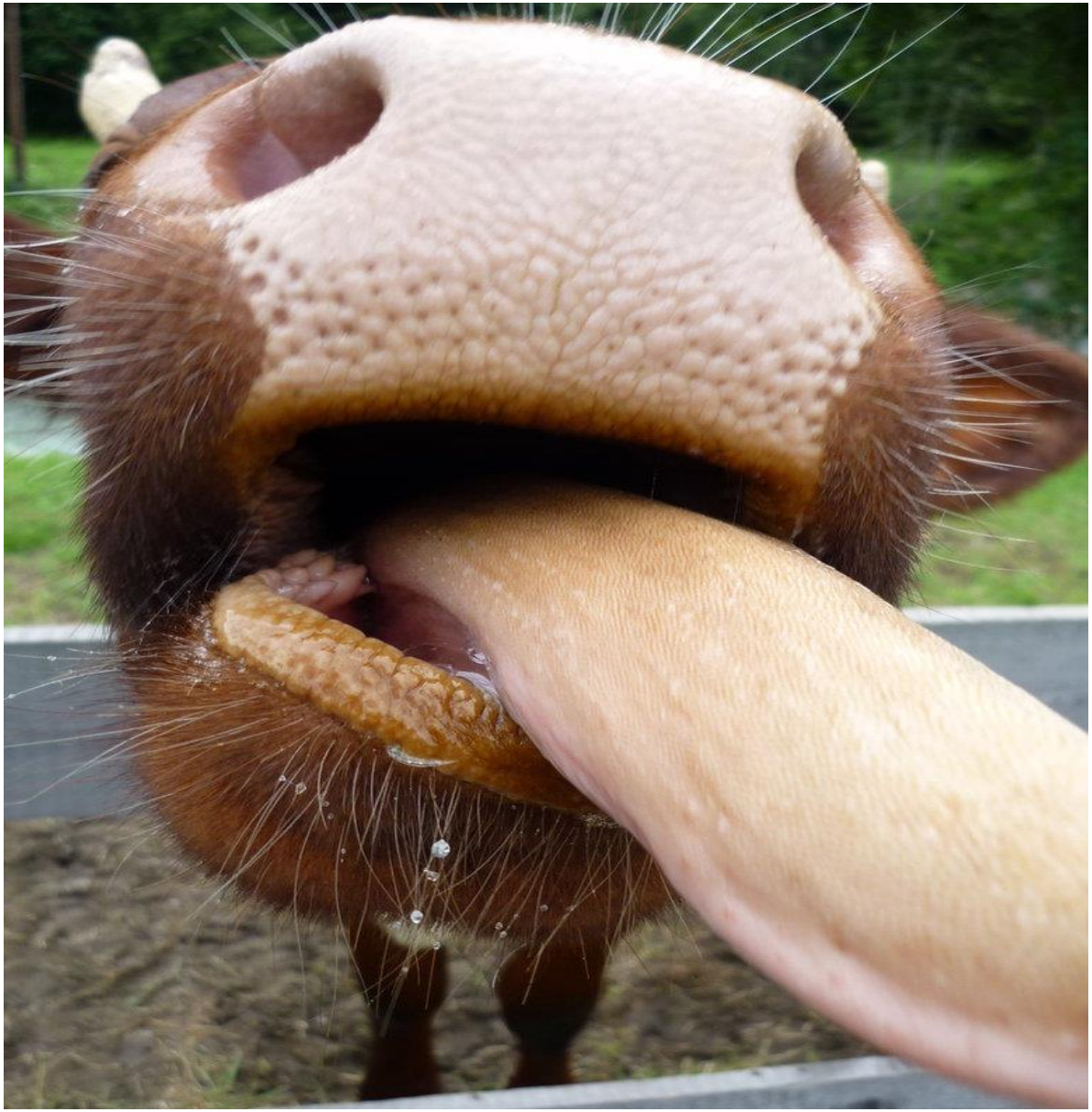
- Includes cavity, its walls and accessory structures that project (teeth, gum and tongue) and drain (salivary gland) into it.
- The main functions of mouth are:
  - ✓ Prehension
  - ✓ Mastication and
  - ✓ In salivation of food.
- It may also play role in **aggression** and **defense** as well as in **formulation of speech of sounds**.
- The cavity of the mouth is subdivided into two parts by the teeth and alveolar processes.
- The space external to the teeth and enclosed externally by the lips and cheeks is called ***vestibule*** .

- The *oral (buccal) cavity* proper lies deep to the teeth and is occupied primarily by the tongue.

Lips (labia) (upper and lower)

- Define entrance into the mouth.
- The appearance and mobility of which vary among species.
- Range from short, relatively immobile in nonselective grazing species to very mobile (prehensile) in selective grazing or concentrate selecting species
- The external parts of the lips are covered by typical haired skin.
- It changes to mucous membrane at the ***mucocutaneous*** junction of the labial margins.

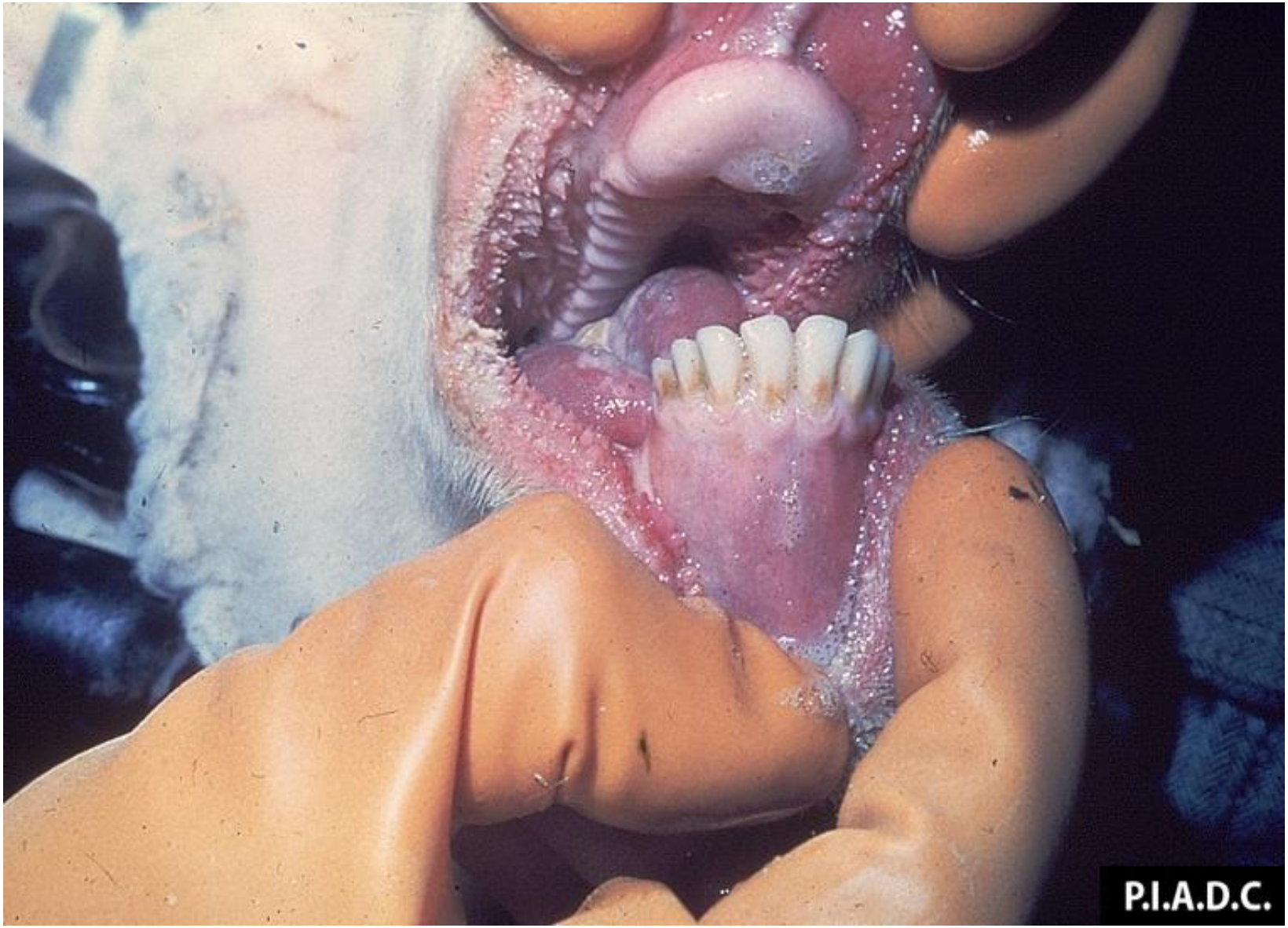
- The upper lip of small ruminants is deeply grooved with a midline ***philtrum.***
- Lips are densely innervated by sensory fibers, making them very sensitive tactile organs.
- The middle part of the upper lip and the surface between the nostrils is bare in cattle.
- It is hard smooth, and (in health) is kept cool and moist by a clear fluid secreted by a layer of subcutaneous glands (**nasolabial glands**) about half an inch thick.
- The free edge and the lining membrane present verrucose, horny papillie.



- The **cheeks (buccae)** form the sides of the mouth, and are continuous in front with the lips.
- They are attached above and below to the alveolar borders of the bones of the jaws.

Gums (gingivae)

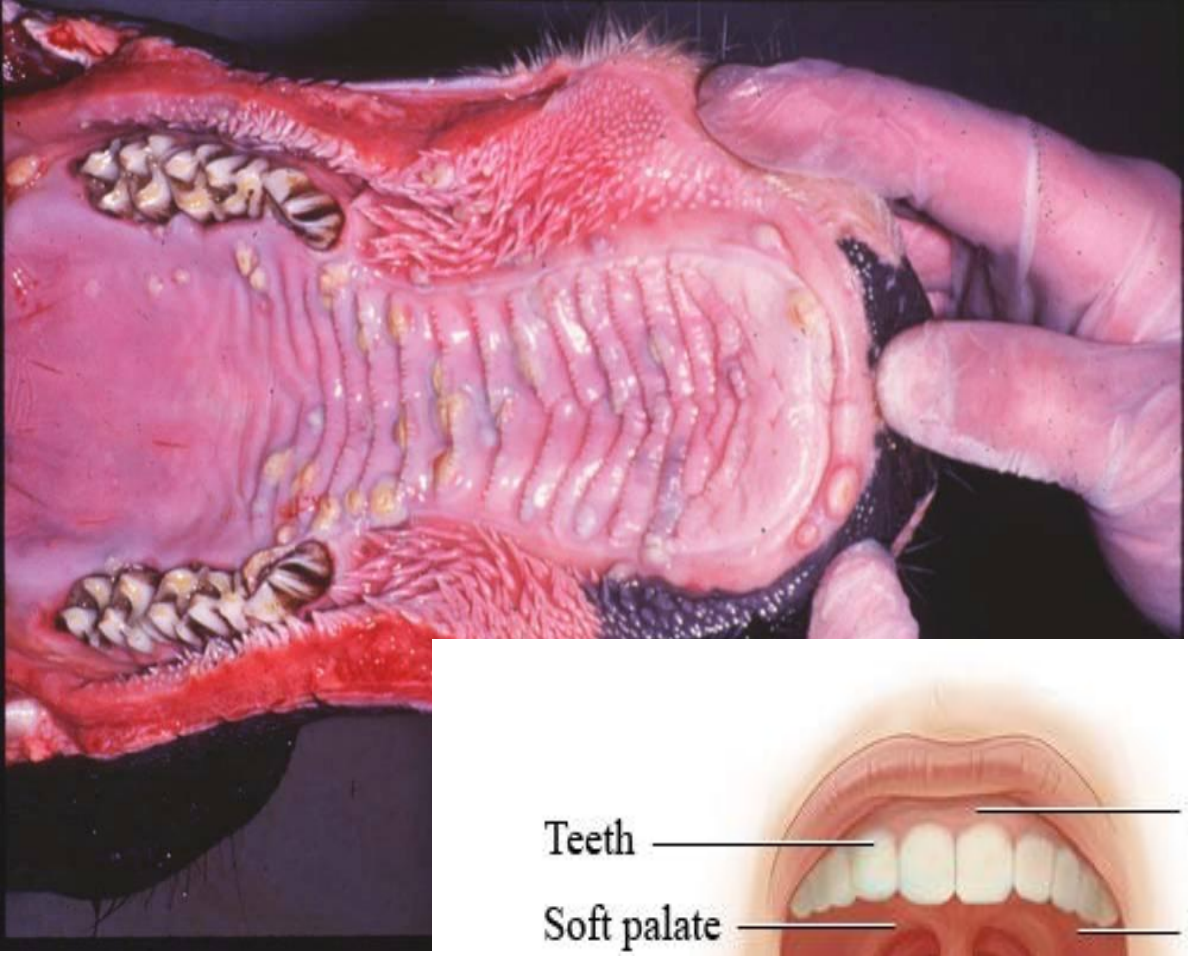
- Are composed of a dense fibrous tissue intimately united with the periosteum of the alveolar processes.
- The epithelium of the gums blends at the edges of the alveoli with the alveolar periosteum, which fixes the teeth in their cavities.
- They are covered by a smooth mucous membrane, destitute of glands, and of a low degree of sensibility.

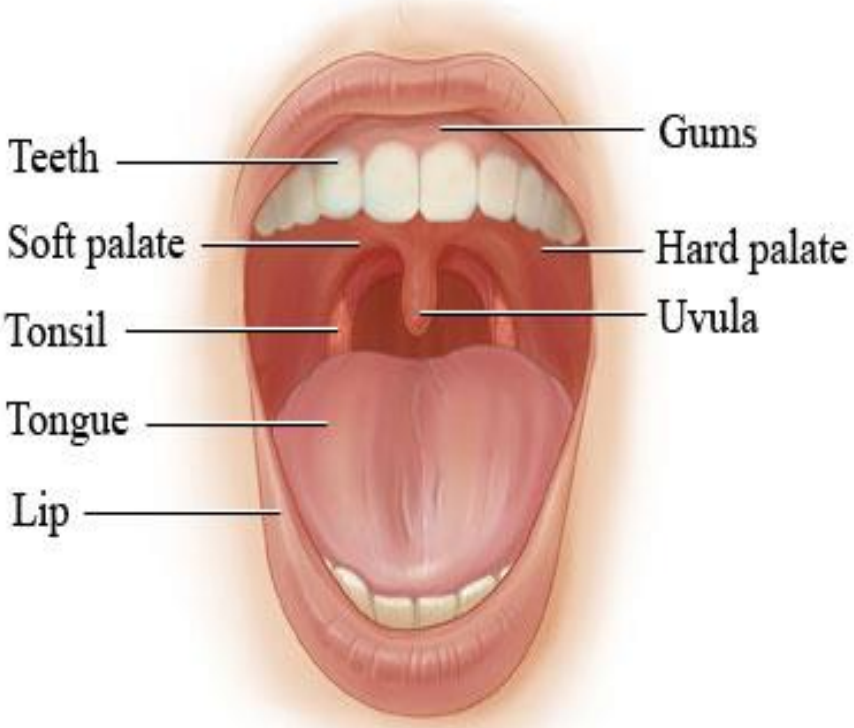

P.I.A.D.C.

- The oral cavity ends at a narrowing (the ***isthmus of the fauces)*** near the base of the tongue, where the digestive tract continues as the pharynx.

Palate

- The dorsal wall of the oral cavity comprises the ***hard palate*** rostrally and the ***soft palate*** caudally.
- The hard palate forms the roof of the mouth
- It is formed by the incisive, maxillary, and palatine bones, which is covered by a dense connective tissue which in turn covered by mucous membrane and collectively form prominent transverse folds called *palatine rugae*.




Teeth
Soft palate
Tonsil
Tongue
Lip
Gums
Hard palate
Uvula

- A linear groove or raphe divides the surface of the hard palate into two equal halves.
- About 15 to 19 transverse ridges are present in each half of the hard palate.
- In ruminant, anterior to the hard palate there are two **dental pads**, one on either side.
- As there are no incisor teeth at the upper jaw of this animal, these dental pads occupy their positions.
- The **soft palate** is a musculomucosal sheet that extends from the root of the tongue toward the base of the epiglottis.
- Separates the cavity of mouth from that of the pharynx.

- In the cow it extends 10cm in the respiratory position to the rostral surface of the epiglottis
- The equine soft palate is **exceptionally long**, and the horse is uniquely unable to actively lift the soft palate so as to permit passage of air from the oral cavity to the larynx.
- For this reason, horses are obligate nose breathers, breathing through the mouth only when the soft palate is displaced dorsal from its normal position ventral to the epiglottis.
- Longer in camel, which form the **palatine divertaculum** (inflated from the buccal cavity of male during breeding season).

2. Tongue

- Highly movable muscular structure (prehensile organ).
- Forms the floor of the mouth, between the two rami of the lower jaw.
- It has a root, a body and an apex.
- The body has three surfaces:
  - ✓upper surface or dorsum is rounded,
  - ✓the lateral surfaces are nearly flat for the most part, but anteriorly become rounded and narrower.
  - ✓The lower surface is attached to the mandible.
- Its caudal part is attached to **hyoid bone**, **soft palate**, and **pharynx**.
- Tongue connected to the soft palate by a mucous membrane fold called ***palatoglossal arch.***

- The apex is free and spatula shaped.
- Structurally the tongue consists of **the mucous membrane**, **the glands**, **the muscles**.
- From the lower surface of the free part a fold of mucous membrane passes to the floor of the mouth forming the ***frenulum linguae***.
- The body of the ruminant tongue has a prominent dorsal bulge called the ***torus lingua***.
- The tongue is covered with thick keratinized stratified squamous epithelium.
- The surface is characterized by a large number of projections, the ***papillae***, which are particularly well developed on the dorsal surface.

- **Filiform**, **fungiform**, and **vallate papillae** are found in all domestic animals, and **foliate papillae** are present in the horse, pig, and dog, but not in ruminants.
- Ruminants additionally have large **conical papillae**.
- The filiform and conical papillae do not bear taste buds (cells specialized for gustation), but all other types of papillae do.
- Taste buds may also be found on the epiglottis, larynx, pharynx, and soft palate.

Filiform

- Papillae are numerous and are distributed throughout the 2/3 of dorsal surface rostral to **transverse groove**.
- They cover the upper surface of the body and tip, to which they give a distinct pile.
- Shorter and softer in horse (Velvety feel).
- But, cornified and sharp in cattle.
- In ruminant the apical half of the dorsum rostral to the torus linguae covered with filiform papillae.
- Makes tongue rough and efficient for prehension in grazing animals(mechanical function).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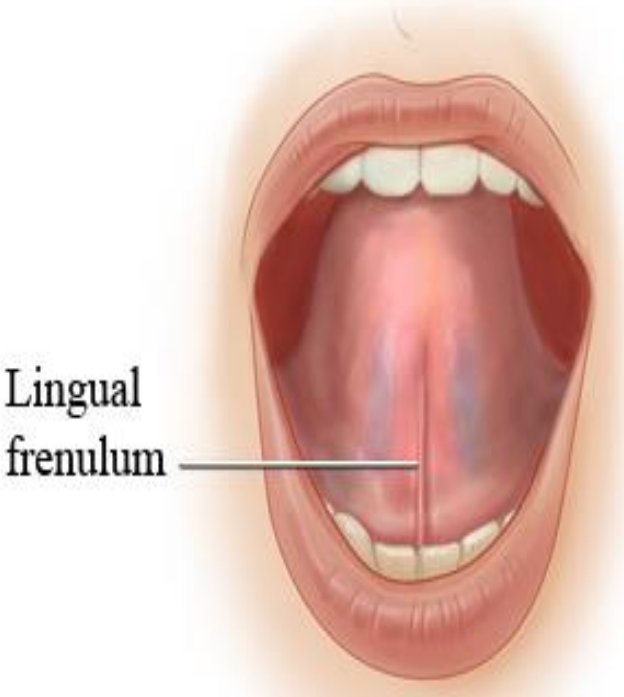

Lingual
frenulum

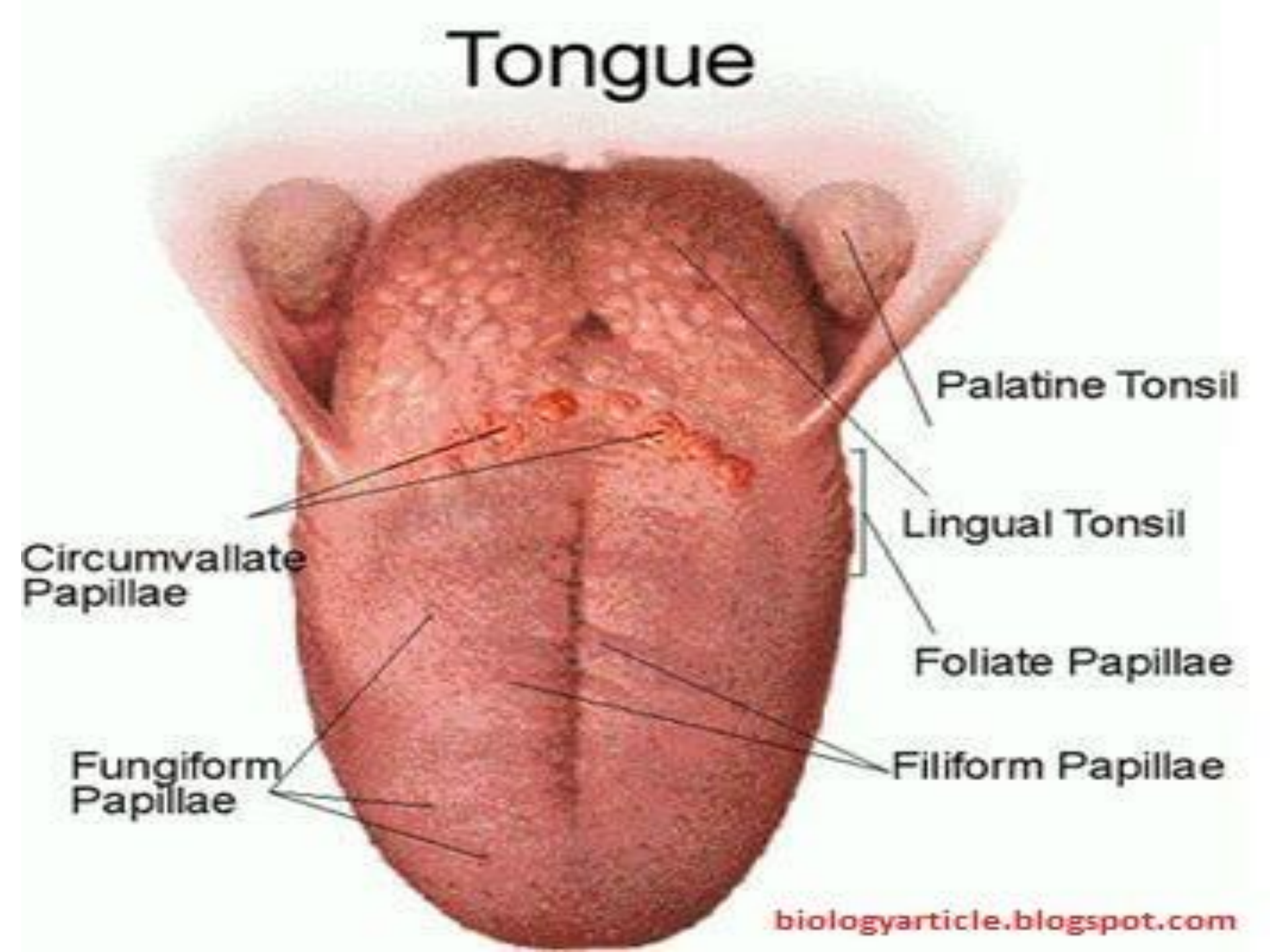
Fungiform

- Resembles a fungus (tiny mushrooms).
- Contain taste buds
- Larger in size
- Located on the lateral part and some are scattered on the dorsum within filiform

Vallate or Circumvallate

- Are large circular projections surrounded by large groove and resembles leave of a plant as it arranged in a V shape on the caudal part of the tongue.
- It demarcate the morphologic division between the body and the root of the tongue.

Tongue


Palatine Tonsil
Lingual Tonsil
Circumvallate Papillae
Foliate Papillae
Fungiform Papillae
Filiform Papillae
biologyarticle.blogspot.com

- Contains taste buds and serous glands and also mucous glands in horse.
- Located on either side of the median plane of the tongue about 3cm apart and they are 2-3 in number.

Foliate papillae

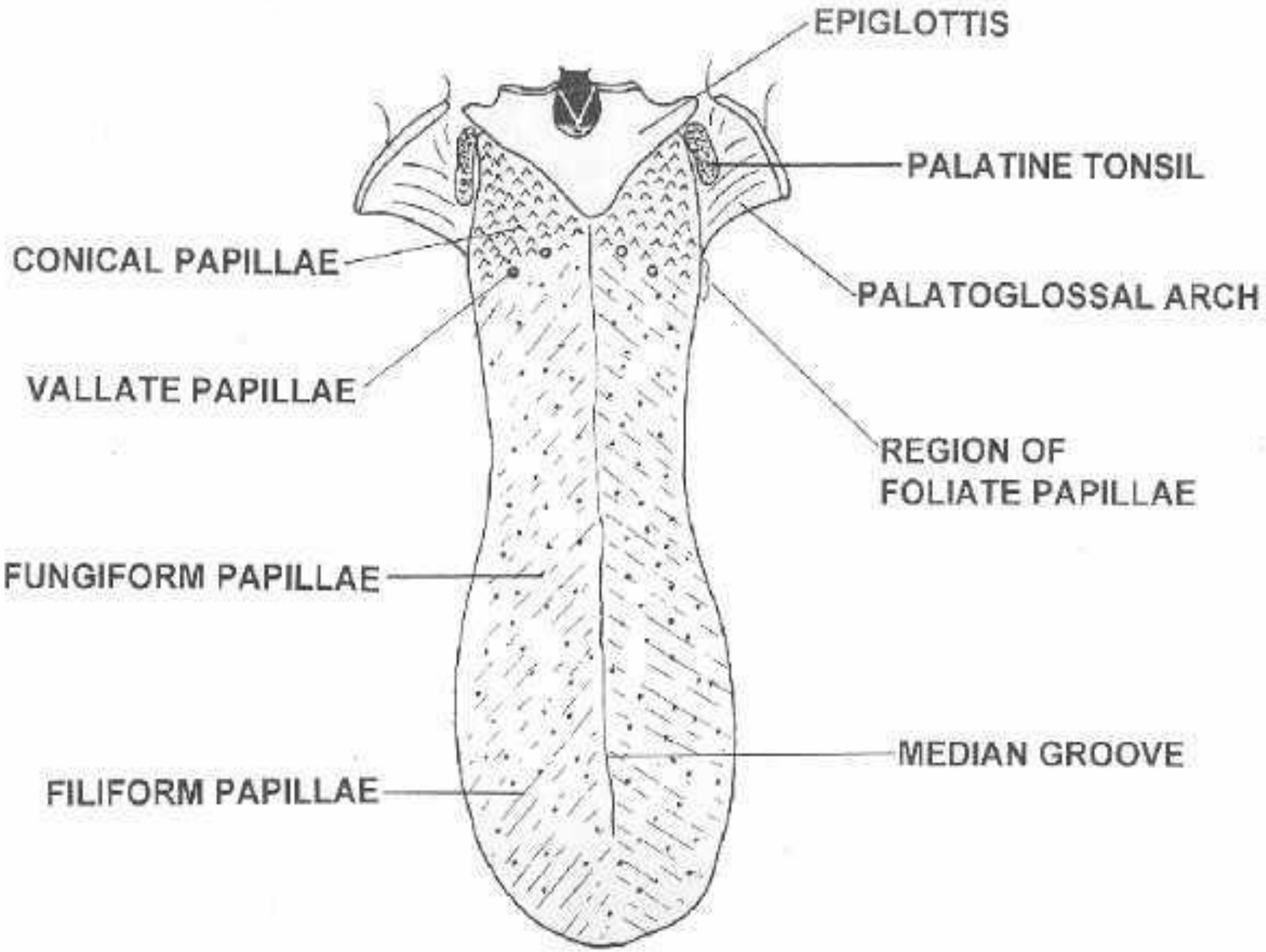
- Located just rostral and on the lateral margin of soft palate adjacent to tongue where the root of the tongue is connected to the soft palate.
- The last three varieties are covered with microscopic secondary papillae and are furnished with taste-buds.
- Present in horse, pig and dog but not in ruminants.

Conical papillae

- The torus lingua of ruminants is thickly covered with prominent conical papillae.
- Similar cornified projections cover the inside of the lips and cheeks.

Uses of tongue

- ✓ Aid in chewing and forming boluses
- ✓ Aid in drinking
- ✓ Prehension of feed
  - Covered with rough, hook-like (filiform) papillae that assist in grasping feed
  - Important in nonselective grazing species
- ✓ Taste
  - Taste buds:
    - More numerous on monogastric species than
    - nonselective grazing species
  - Primarily used for food avoidance


EPIGLOTTIS
PALATINE TONSIL
CONICAL PAPILLAE
PALATOGLOSSAL ARCH
VALLATE PAPILLAE
REGION OF
FOLIATE PAPILLAE
FUNGIFORM PAPILLAE
MEDIAN GROOVE
FILIFORM PAPILLAE

3. Teeth

- Teeth are the hardest structures in the body.
- Teeth are arranged in two ***dental arcades***, one associated with the mandible and one with the incisive and maxillary bones.
- Mammals typically have a gap in each arch between the front teeth (incisors) and the cheek teeth; such a physiologic gap is called ***diastema.***
- Mammalian dentition is classified as ***heterodonty,*** since they have various types of teeth developed in different regions that are specialized/adapted for specific function.
- This allow recognition of **incisor**, **canine**, **premolar**, and **molar groups**.
- It implanted into the alveolar sockets of the upper and lower jaw bones.

- The part that is in the socket is **root** , but the part of the tooth visible which is out above the mucous membrane of the gum is **crown** and the area of union of root and crown is **neck**.
- Neck may not found on all teeth (***hypodont)*** e.g. equine incisors while in some teeth neck is there discernably ***(brachyodont)*** e.g. incisors of cattle.
- Some teeth have multiple roots.
- In the interior of the teeth is pulp cavity which contain soft material including blood vessels and nerves.

Surfaces of teeth

- ✓ Free surface (occular surface): top surface
- ✓ Vestibular surface: the side nest to the vestibule
- ✓ Lingual surface: inner surface
- ✓ Contact surface: side in contact with the neighboring teeth in the same jaw.

In some animals the occular surface of the tooth form an infundibulum or cup.

- ➢ All domestic animals also are ***diphyodont.***
- ➢ This means they develop a set of ***deciduous teeth*** (also called baby teeth or milk teeth)during young age that fall out and are replaced with ***permanent teeth*** during adulthood .
- ➢ As growing teeth emerge from the gums, they are said to ***erupt.***

- When their occlusal (grinding) surfaces meet those of the teeth in the opposing arcade, they are said to have come into ***wear.***
- ***Eruption*** times of teeth are consistent enough to permit accurate aging of young animals by observing their dentition.
- The age of animals with a full set of permanent teeth can be estimated through examination of the wear patterns of the occlusal surfaces.
- A tooth is anchored by its root in a socket of bone called an ***alveolus.***
- A connective tissue, the ***periodontium*** (also called periodontal membrane), firmly attaches the cementum of root to the surrounding bone in a specialized joint called ***gomphosis.***

Structure of teeth

Dentin (dentine): Forms most of the tooth's substance from a mineralized substance with a dental cavity at its center.

Dental pulp (pulp cavity): The cavity in interior of the tooth in which connective tissues, nerves, and blood vessels of the tooth resides**.**

Enamel: hard whitish layer consisting of inorganic crystals which is found superficial to the dentin. Enamel is the hardest substance in the body.

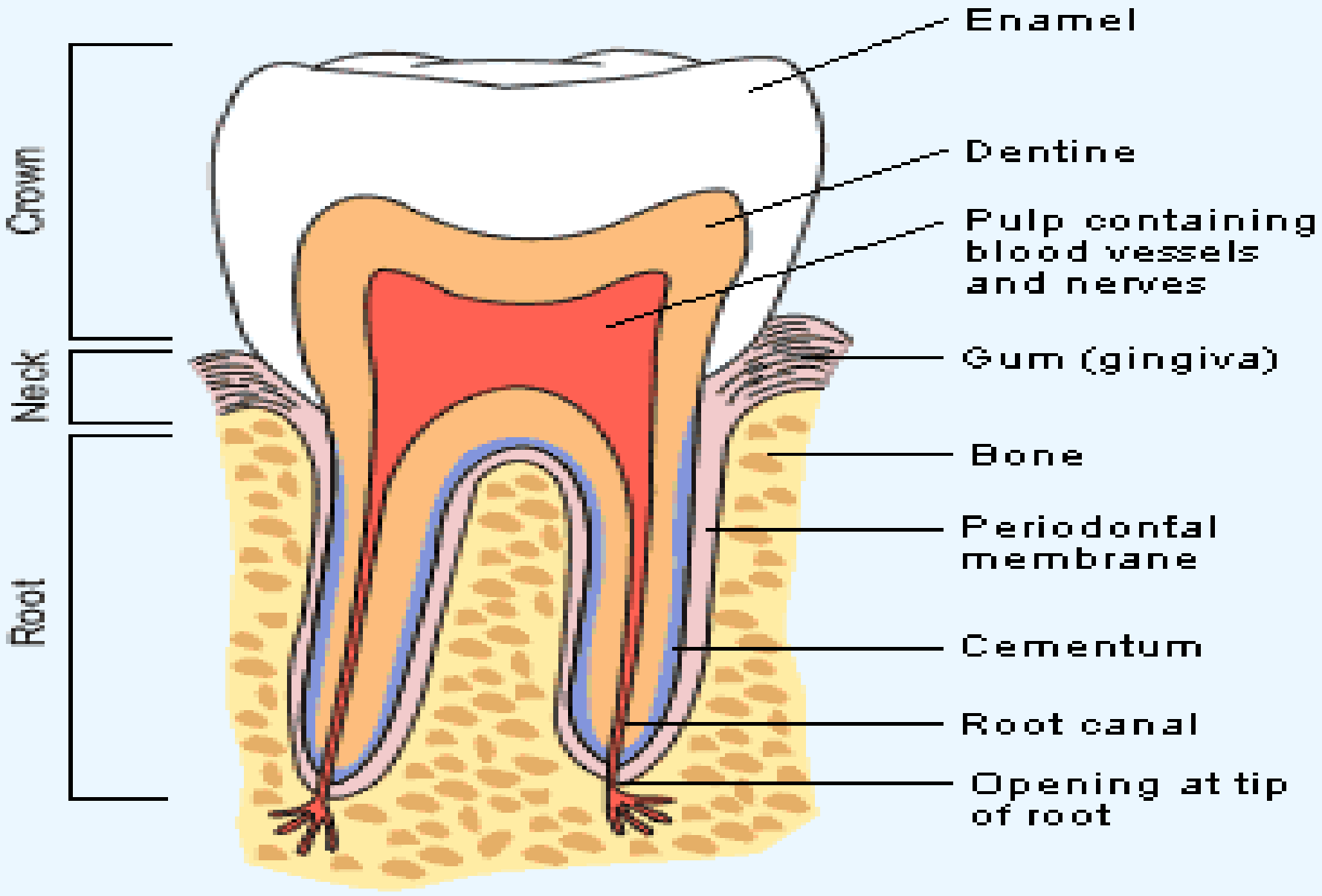
- It covers crowns of brachyodont and nearly entire of hypsodont teeth.

- It is irreplaceable, exception being the tusks (canine teeth) of swine.
- The enamel of *hypsodont* teeth is thrown into prominent folds on the grinding surfaces of these teeth, where they form characteristic crests (***cristae enameli***) and cups (***infundibula***).

Cementum: is a thin, bonelike layer on the surface of the tooth.

- It covers only the root of the brachyodont tooth, but it extends from the root to cover the crown of the hypsodont tooth.

NORMAL TOOTH



In diphyodont animals there are two generation of teeth:

Deciduous or milk teeth

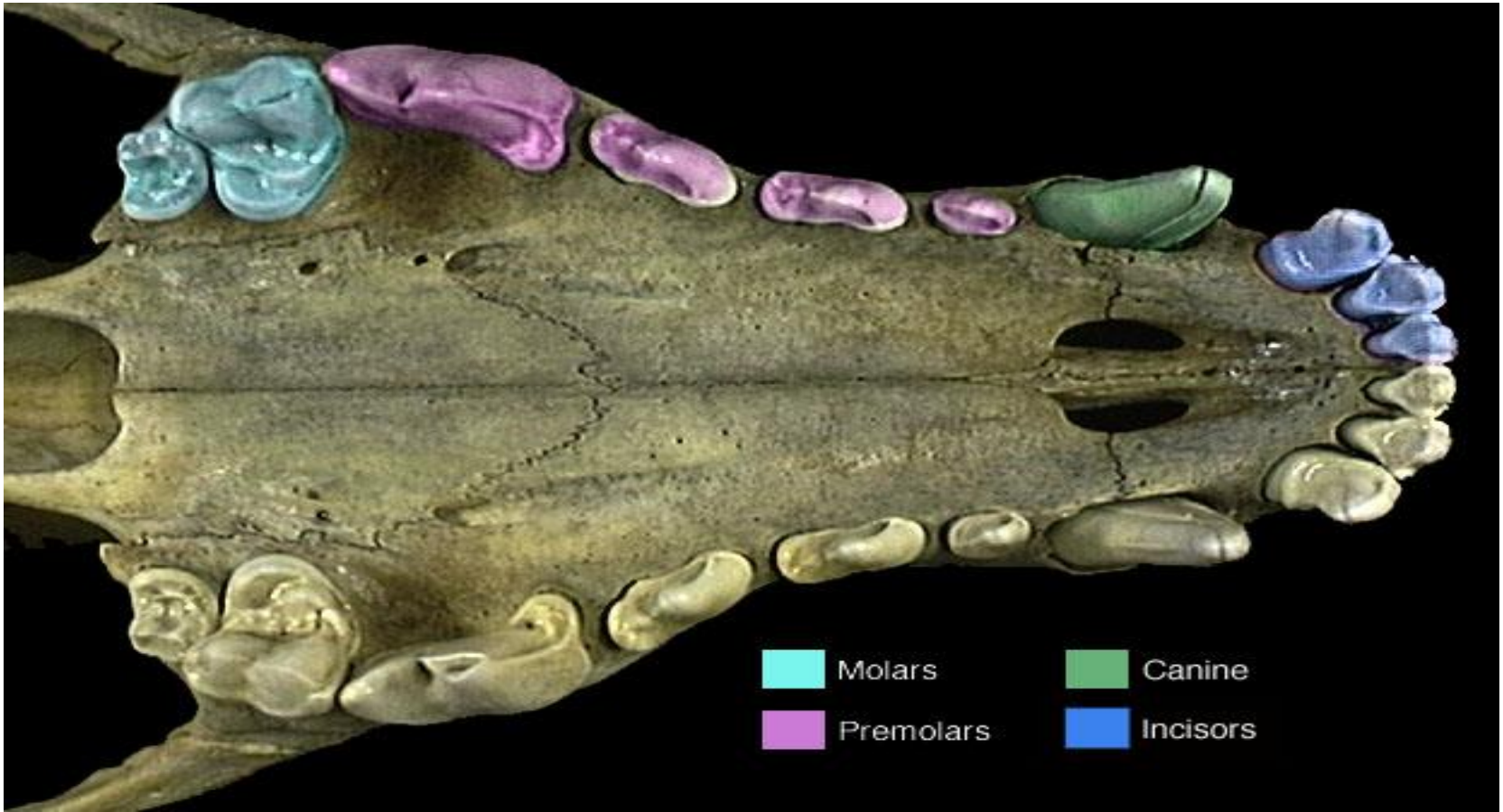
- This is a temporary set of tooth and is replaced by permanent set.
- These milk teeth are found at birth or within few weeks after birth.

Permanent teeth

- Are permanent set of teeth developed after deciduous teeth were worn out.
- They stay for long time once they have erupted; likewise, once they have ruined there is no replacement

There are four different types of teeths:

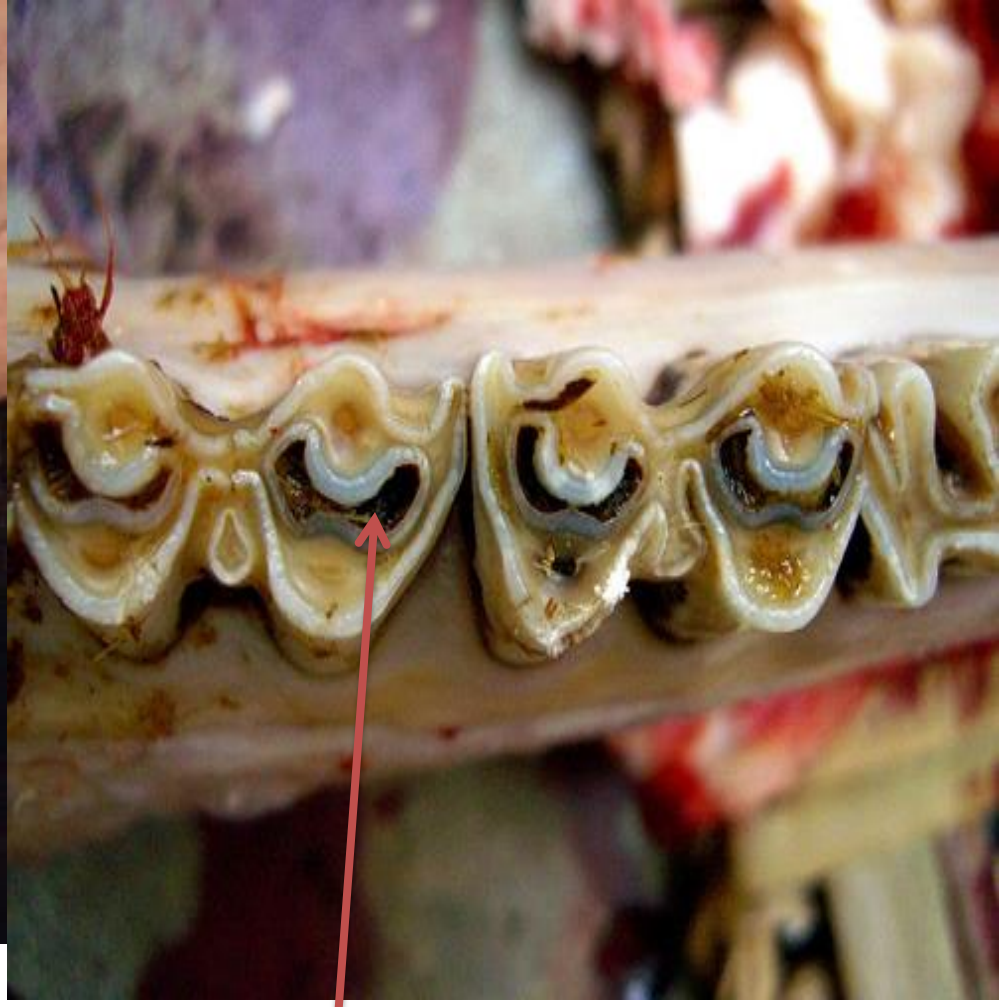
- ✓Incisors: cutting
- ✓Canine: seizing and tearing
- ✓Premolar: shredding and grinding of the food
- ✓Molar: shredding and grinding of the food



Incisors:

- The front teeth are called ***incisors***, and in dental formulas, they are designated by the letter I.
- The incisors are numbered starting from the midline.
- The first pair of incisors is called I1, or *centrals;* the next pair *I2, or first intermediates;* next I3, or *second intermediates; and the last* and most lateral pair of incisors is called I4, or *corners.*

Incisor teeth

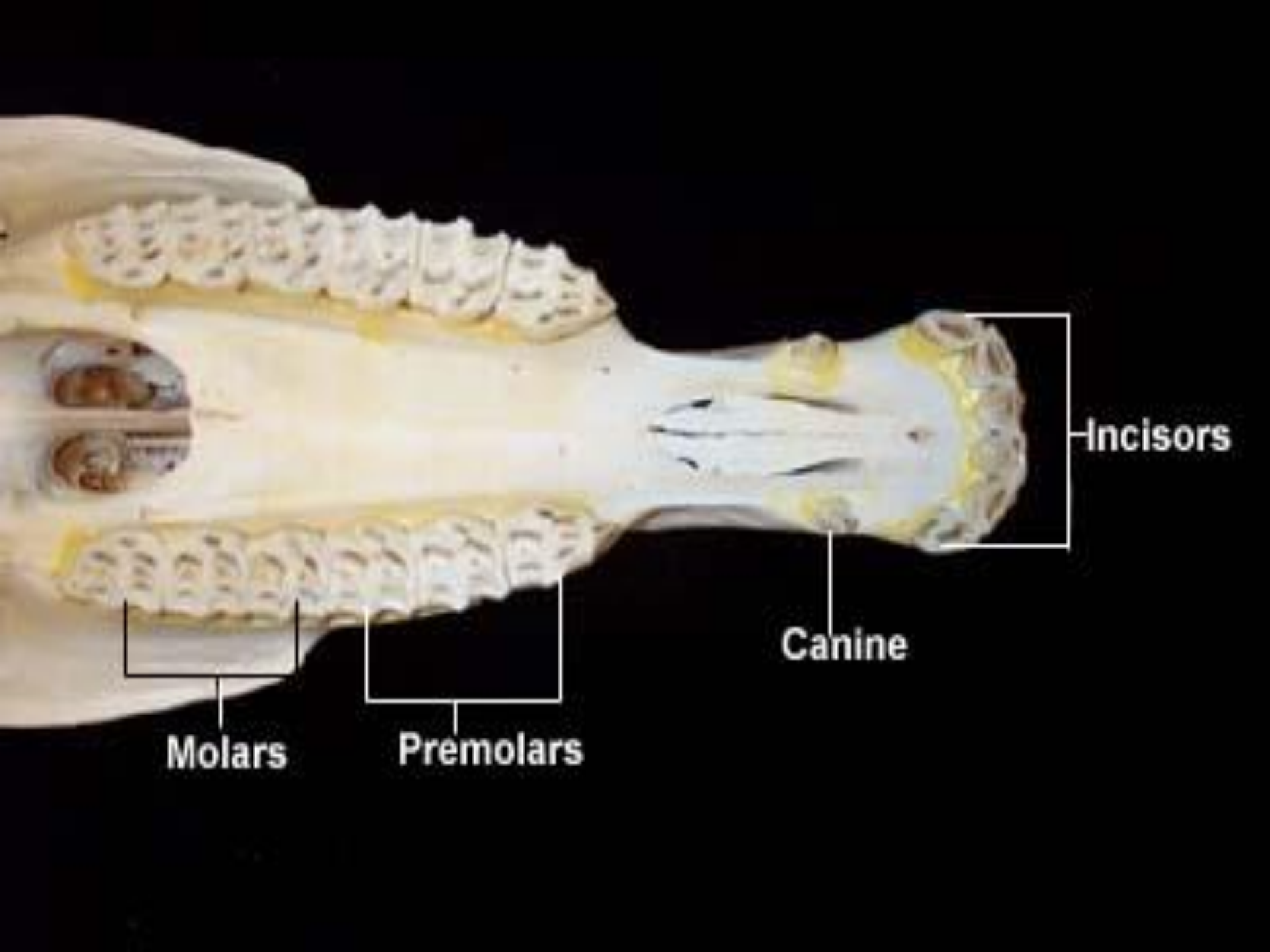


Infundibulum

- In the non ruminants, only one pair of intermediate incisors is found.
- Ruminants lack incisors in the upper dental arcade.
- Instead, the mucous membrane in this region is modified into a dense, keratinized ***dental pad***, against which the lower incisors abut when the jaws are closed.
- Permanent incisors are preceded by a like number of deciduous teeth.

Canine teeth

- Abbreviated (C) are also called eyeteeth, bridle teeth, tusks, and tushes.
- Ruminants lack canine teeth.
- They can be well developed in stallions and in small animals (dogs and cats), they are small or absent in mares and geldings.
- The canine teeth of pigs are large, especially in boars, and in this species they are usually called **tusks**.


Incisors
Canine
Premolars
Molars

- Porcine tusks are described as ***open rooted,*** meaning that they continue to grow throughout life.
- The lower tusk is generally much larger than its partner in the upper arcade.
- In pigs, the permanent canines are preceded by analogous deciduous teeth; in the horse, the deciduous canines are often absent or so small that their crowns do not erupt.

Cheek teeth

- Comprise premolars (P) and molars (M), which in herbivores are morphologically similar.
- Only premolars are preceded by deciduous teeth; the molars have no precursors.
- In the pig, the molars are larger than the premolars and have a flatter occlusal surface, in keeping with their grinding function.

Horse cheek teeth

Deciduous Teeth formulas

Horse	Ox and Sheep	Pig	Dog and cat
I3 C0 P3	I0 C0 P3	I3 C1 P4	I3C1P3
I3 C0 P3	I4 C0 P3	I3 C1 P4	I3C1P3

Permanent teeth formula

Horse	Ox	Sheep	Pig
I3C1P3-4M3	I0C0P3M3	I0C0P3M3	I3C1P4M3
I3C1P3M3	I4C0P3M3	I4C0P3M3	I3C1P4M3

Dog and cat

I3C1P4M2

I3C1P4M3

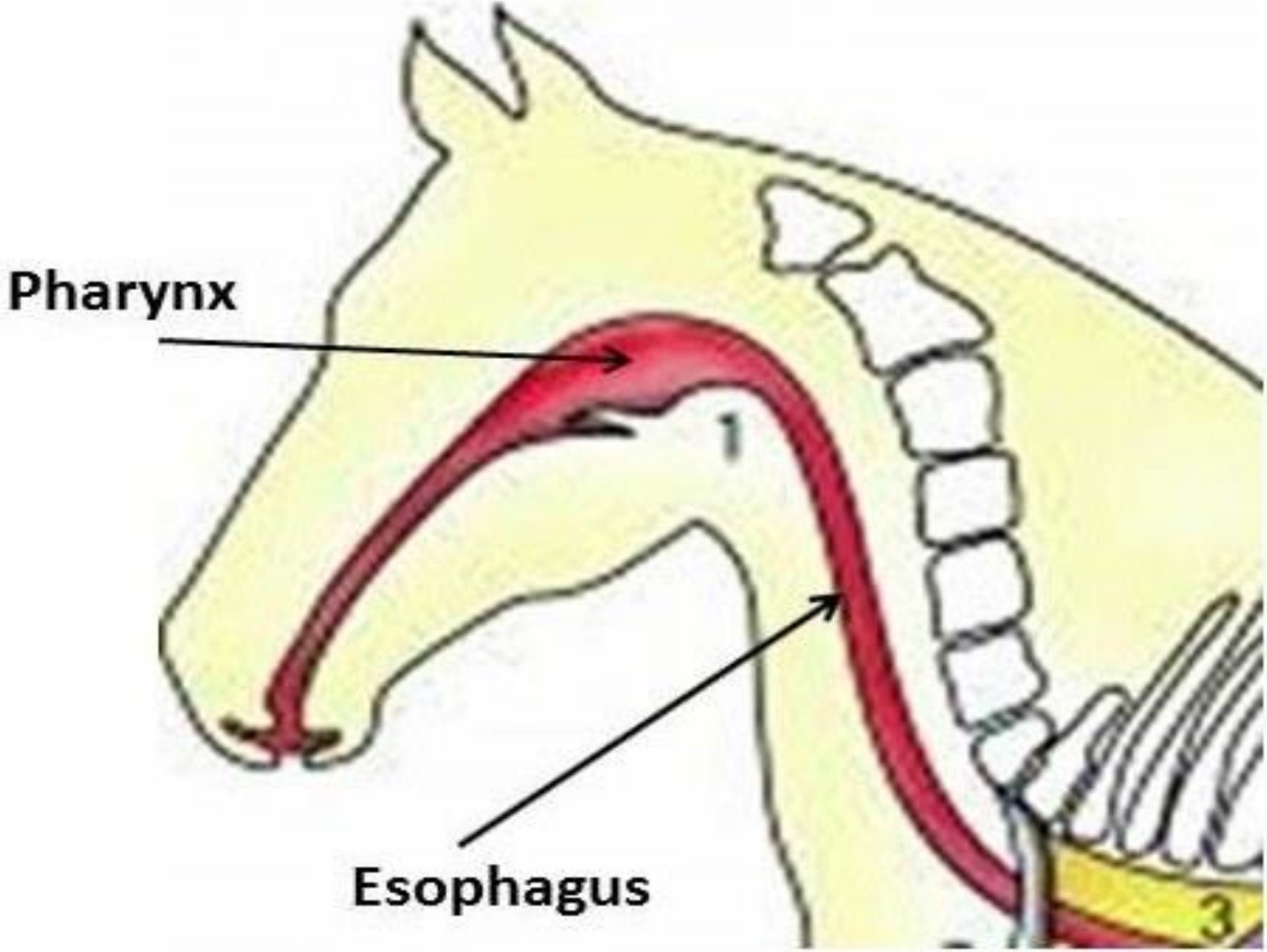
3. Pharynx

- It is roughly a funnel shaped behind the posterior nasal aperture.
- Found directly is caudal to oral and nasal cavities, and is lined by mucous membrane and surrounded by muscles.
- It connects the nasal and oral cavities with the trachea and esophagus respectively.
- Serving to direct the intake of food and air in to their proper channels.
- Pharynx can be arbitrarily divided into nasal (***nasopharynx),*** oral (***oropharynx),*** and ***laryngeal (laryngopharynx)*** portions, so named for their association with these regions.

- The dorsal part of the pharynx above the soft palate is known as **nasopharynx.**
- The portion, dorsal and lateral to the larynx is known as **laryngopharynx.**

- The cavity of the pharynx communicates with other structures by seven openings.
  - ✓two for Eustachian tubes,
  - ✓two for posterior nares,
  - ✓one for esophagus,
  - ✓one for mouth and
  - ✓one for larynx.

- There are plenty of mucous glands in this layer.
- The paths of air and swallowed substances must cross in the pharynx; pharyngeal dysfunction can have severe consequences for the airway, which must be protected from foodstuffs.
- The pig has a ***pharyngeal diverticulum*** that opens into the dorsal wall of the pharynx near the beginning of the esophagus.
- Care must be exercised not to enter this diverticulum while passing a stomach tube or giving medications via a balling gun.

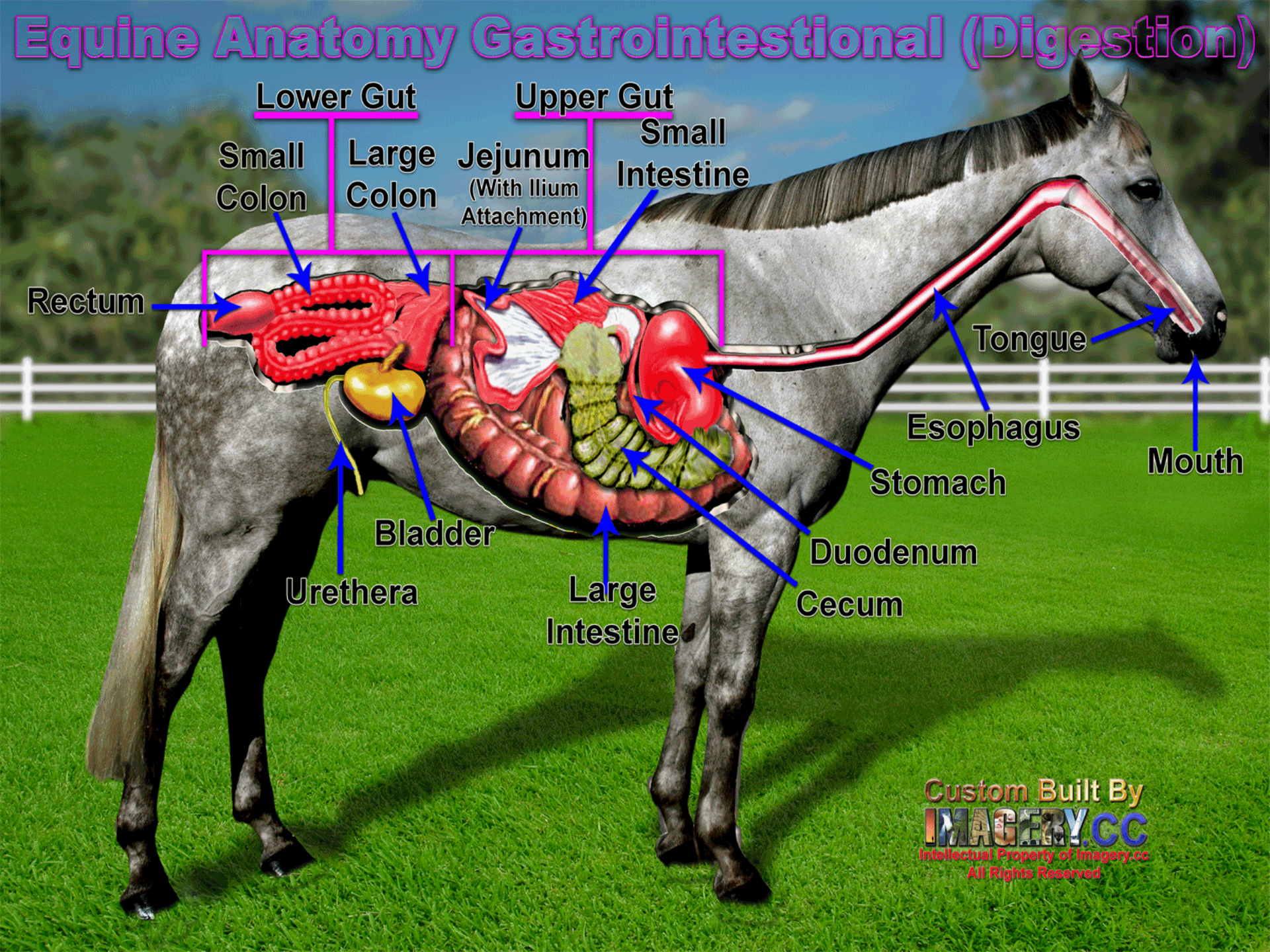

Pharynx
Esophagus
1
3

- Superiorly it is related to guttural pouches in equines.
- Guttural pouches are a pair of large mucous sacs situated on either side of the midline above pharynx.
- These are downward diverticulum from the auditory tubes and.

4. Esophagus

- Mucous membrane lined muscular tube running from pharynx to rumen; stomach in monogastric animals.
- Involved in rumination and eructation.
- It has been divided into three parts-cervical, thoracic and abdominal.
- The average length is about 90cm in ruminants and 140cm in horse

Equine Anatomy Gastrointestional (Digestion)



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- Differences ruminant of esophagus from monogastrics
  - Circular and longitudinal muscles are striated muscle along the entire length
    - Provides greater strength
    - Allows some voluntary control
  - Funnel shaped
  - Positioned between lungs
- In ruminants, the abdominal part is practically absent (close apposition diaphragm) while in horse the abdominal part is **2cm** long.

Course and relation

- It starts as the continuation of the pharynx.
- Related ventrally to the dorsal aspect of the trachea and dorsally to the longus coli muscle.

- At the level of 3rd cervical vertebra the esophagus descends to the left surface of the trachea and maintains this relation up to 6th cervical vertebra.
- Then, it goes little upward and enters the thorax through the dorsolateral aspect of the thoracic inlet.
- At the level of 3rd to 4th cervical vertebrae it is related superiorly to the left longus coli, laterally to the vagosympathetic trunk, common carotid artery and internal jugular vein.
- In the thorax it gains the dorsal surface of the trachea and continues with this relation up to the level of the tracheal bifurcation.
- Enters the abdominal cavity through esophageal hiatus along with the dorsal and ventral continuations of vagus nerves.

- At the base of the heart it is related to the aortic arch at the left side.
- In the posterior mediastinum it is related to the mediastinal lymph nodes and corresponding lung on either side.
- Just after entering the abdomen it opens into the stomach at a dome shaped area between the dorsal sac of rumen and reticulum, known as **atrium ventriculi**.

Thank you!!!

Stomach (Gaster)

- Stomach is a large dilation caudal to the diaphragm.
- The structure of stomach is determined by way of life and feeding habit of the animal.

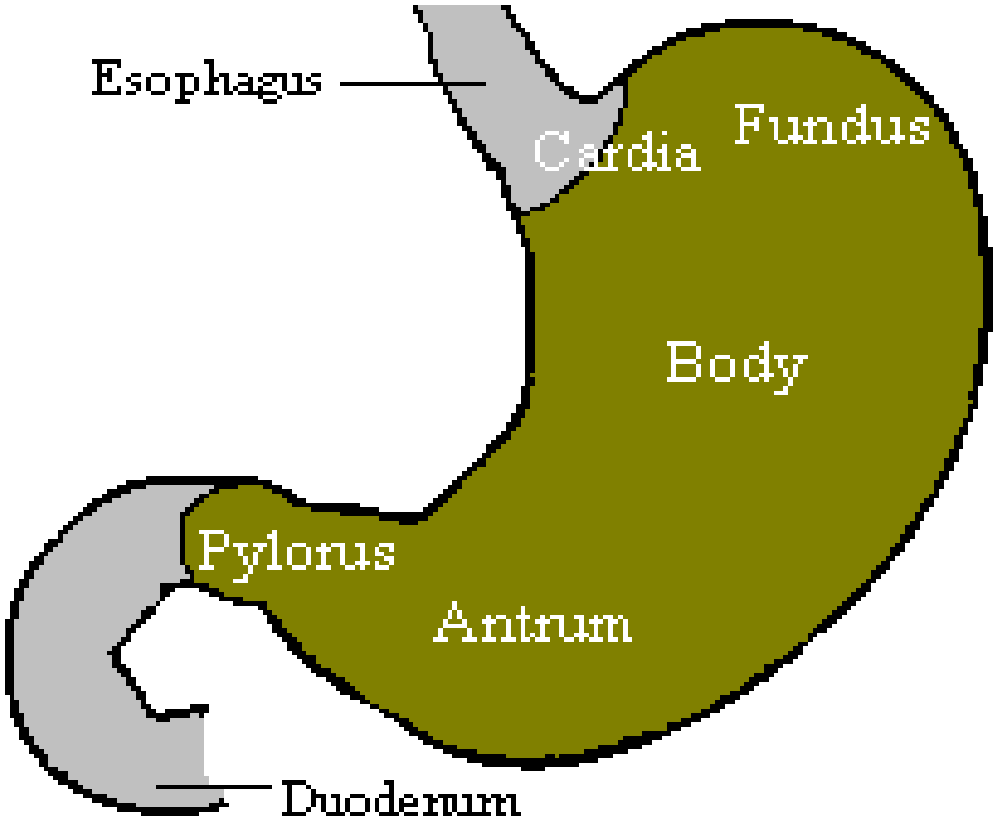
There are two major kinds of stomach in mammals

- Simple stomach is found in:
  - Pig, horse, primates and carnivores
- Compound stomach is found in:
  - Ruminants (bovine, ovine and caprine)
  - Pseudo ruminants -camels, llama

In ruminants the glandular stomach is separate compartment called abomasum and large compartment also called forestomach is composed of rumen, reticulum and omasum.

Simple stomach (Non ruminant stomach)

- Further distinction according to the nature of the inner lining simple stomach is divided into 4 region based on cell type. These are:
  - Oesophageal--non glandular
  - Cardiac
  - Fundic--glandular
  - Pyloric
- Sharply curved J shaped sac

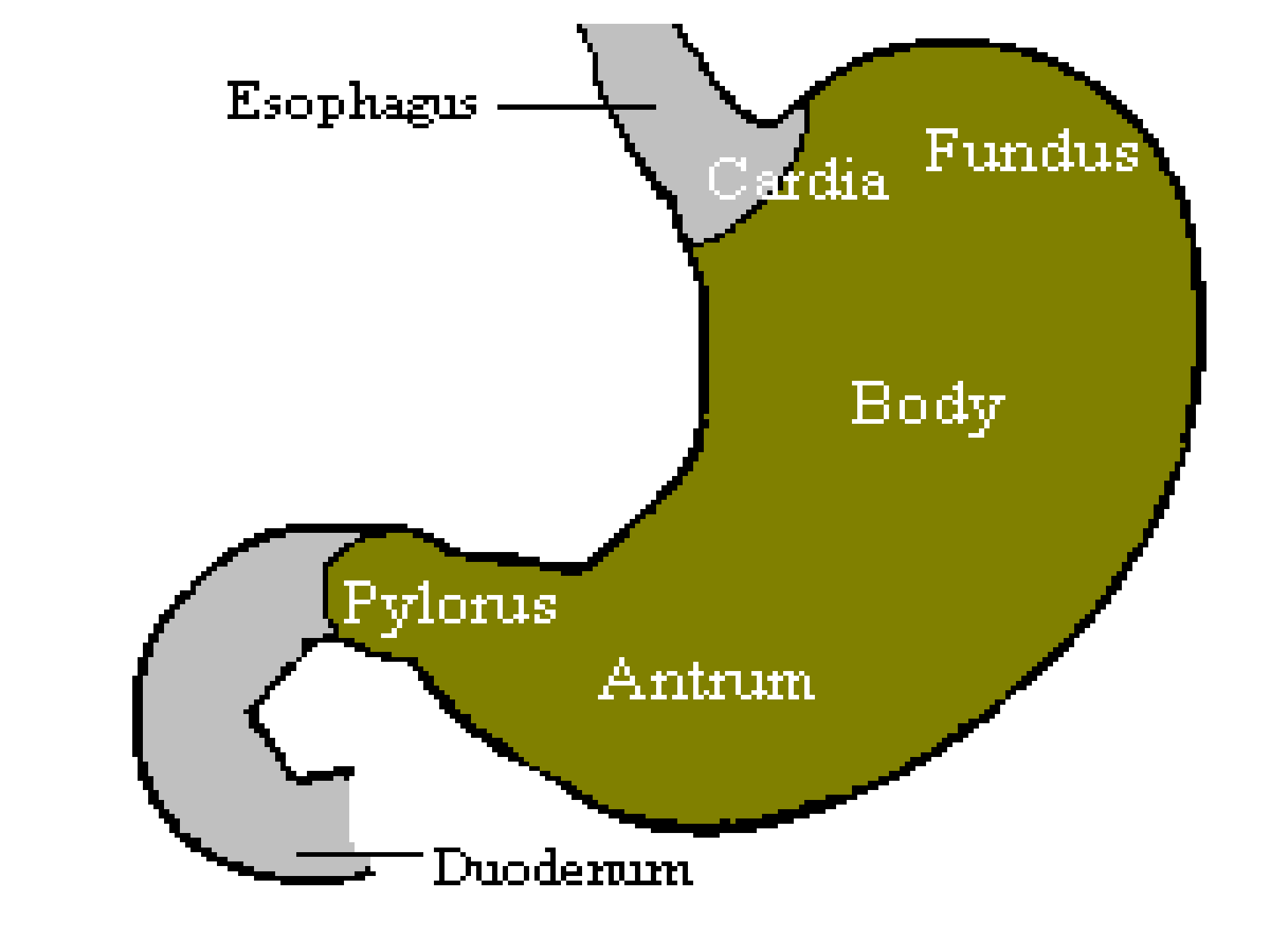


- In carnivores, completely lined with glandular mucosa.
- In ruminants, pigs and horse oesophageal region is non glandular and also called fore stomach (proventiculus).
- In pig it is small size zone around the cardia.
- The mucosa of the abomasum is arranged in spiral folds.

- The junction between the non glandular portion of the mucosa and the glandular mucosa occurs at the:
  - Cardia – in pig and is an elongated strip which extends into and partially lines the gastric diverticulum

Simple stomach

- Presents two surfaces – parietal (cranial) & visceral (caudal)
- Two extremities – left & right
- Two curvatures - greater & lesser


Esophagus
Cardia
Fundus
Body
Pylorus
Antrum
Duodenum

Parietal surface

-Convex surface directed cranial, dorsal

-Lies close to the diaphragm & liver

Visceral surface

-Concave surface that faces opposite to parietal surface

-Related to pancreas, terminal part of large colon, small intestine and greater omentum

Lesser curvature

-Forms terminal part of oesophagus to the junction of SI in the right side

Greater curvature

-Extensive part in the left side related to the spleen

Left extremity

Ventral to right crus of the esophagus

Right extremity

Right to the median plane in contact with visceral surface of the liver.

There are two openings in the stomach guarded by sphincters

- **Oesphageal orifice\cardiac ostium**
  - The opening of esophagus to stomach guarded by **cardiac sphincter**
- **Pyloric ostium**
  - Passage (opening) way into duodenum guarded by **pyloric sphincter**

- **Gastropherenic -** connects greater curvature of stomach to crura of diaphragm
- **Lesser omentum** connects lesser curvature & first part of duodenum with the liver
- **Greater omentum** – connects greater curvature and 1st curue of Duodenum to the dorsal body wall
- **Gastrosplenic -** connects greater curvature to the hilus of spleen.

Ruminant stomach

The compound stomach

- Occupies almost 75% of the abdominal cavity
- Consists of four compartments in ruminants e.g. bovine, ovine & caprine
  - Fore stomach (rumen, reticulum & omasum)
  - True stomach (abomasum)
- Consists three compartments in pseudo ruminants e.g. camel
  - Fore stomach (rumen & reticulum)
  - True stomach (abomasums)

	% of mature volume	Volume, l	
		Cattle	Sheep
Rumen	80	60-100	9-18
Reticulum	5		
Omasum	5-8	6-10	1-2
Abomasum	5-8	5-8	2

- Full capacity of the reticulorumen is only used in animals fed low quality roughages.
- Only 60 to 70% of the total capacity is used in animals fed high quality roughages.

- The forestomachs have non glandular mucosa whereas true stomach has glandular mucosa.
- Oesophagus opens into a narrow roof between the rumen and reticulum (atrium ventriculi).

The capacity of the stomach:

- Varies with age and size of the animals
- In new born animals abomasum is larger than all the other 3 compartments all together constituting up to 60%.
- They are non-functional when diet is restricted to milk.
- But as the age advances and the new born starts to take solid food, rumen develops very rapidly and exceed the size of the other compartments

A. Rumen

- 1st compartment
- Occupies most of the left half of abdominal cavity
- The organ that allows for bacterial and chemical breakdown of fiber.
- The rumen has a very thick, muscular wall.
- Extends from the diaphragm to the pelvic inlet
- It makes contact with the left abdominal wall from 8th inter-costal space to the transverse plane of tuber coxae

- It presents:
  - **Two surfaces**
    - Parietal (left) surface
      - Related to diaphragm, spleen & left wall of abomasum
    - Visceral (right) surface
      - Related to omasum, abomasum, intestine, liver & pancreas
      - Bears two grooves
        - »Right longitudinal groove – ventral
        - »Right accessory groove – dorsal

- **Two curvatures**
  - »Dorsal curvature
  - »Firmly attached to the diaphragm and sublumbar muscles by peritoneum
  - »Ventral curvature
  - »Lies on the abdominal floor

Rumen interior:

- At the cranial end of the rumen there is ruminoreticular orifice that externally corresponding with ruminoreticular groove.
- Cranial pillar – internal septum corresponding to the cranial groove forms the caudal limit of the cranial sac (atrium ruminis).
- Right longitudinal pillar extends to the caudal pillar and it corresponds to the right longitudinal groove.
- Right accessory pillar – found dorsal to the right longitudinal pillar.
- Left longitudinal pillar internal septum corresponding to the lift longitudinal groove which doesn’t reach the caudal pillar

- The pillar partition of rumen into different sacs:
  - Cranial sac
  - Dorsal sac
  - Ventral sac
  - Caudodorsal blind sac
  - Caudoventral blind sac
- The mucus membrane is greenish brown or black except on the margin of the pillar
- The mucus membrane is thickly studded with large papillae.
- The papillae are absent from the edges of the chief pillars

The papillae are

- Absorptive organs
- Their growth is stimulated by the product (VFA, Vit B complex, gasses) of bacterial fermentation in the rumen and reticulum.

B. Reticulum

- honeycomb-like interior surface, this part helps to remove foreign matter from the food material.

- The most cranial compartment
- The smallest of all compartment in ox
- Located between 6-8 ribs mainly left to the median plane
- The diaphragmatic surface lies against the diaphragm

- It relation to diaphragm and hence to the pericardium cause foreign body (user nail & wire) that lodge in the reticulopericarditis.
- Ruminoreticular orifice –orifice between rumen & reticulum
- It is also in contact with omasum & abomasums

Reticulum

- Ruminant animals grasp mouthfuls of food and swallow it before it is chewed.
  - They wrap their tongue around a mouthful of grass, clamp down their teeth, and pull to break the grass at its weakest point, and swallow.
  - Ruminants will “chew their cud” (regurgitate) their food material and then grind it with their molars at a time when the animal is resting.
  - This is done until the food particles are small enough to pass through the reticulum from the rumen.
- Since ruminant animals do not “chew” their food when it is taken in, at times foreign material like rocks, nails, small pieces of wire, can be swallowed.

- While the animal is “chewing its cud” foreign particles that are heavy are allowed to “sink” in the reticulum, preventing many foreign particles from entering the rest of the digestive system.
- Once foreign material enters the reticulum, it stays there for the life of the animal.
- If enough of this foreign material remains in the reticulum, it may cause damage and infection of the reticulum (hardware disease).

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C. Omasum

- Ellipsoidal (ball) shaped mass.
- Lies to the right of the median plane opposite 7 to 11 ribs.
- The parietal surface is in contact with rumen, reticulum & abomasum.
  - Omasum - section that is round and muscular.
    - "Grinds" the food material and prepares the food material for chemical breakdown.
- Most of its ventral surface is in contact with abdominal floor.
- Omasoabomasal orifice–an opening that joins omasum with abomasum.

Bear about 100 in ox and 80 in sheep longitudinal folds termed butcher's bible (laminae).

The surface of these laminae are studded with low rounded papillae.

When the omasum relaxes a portion of the ingesta passing through it enters between the laminae and the juice released is absorbed, finally digested food moved to abomasum and coarse well undigested food returned back to the reticulum.

D. Abomasum

- Is an elongated sac which chiefly lies left to the median – plane
- Fundus – cranial blind sac – found in xiphoid region
- Body – part that extend b\n ventral sac of rumen & the omasum
  - chifly lies right to the median plane
- Pyloric part – turns to the right caudal to the omasum
  - joins duodenum at pylorus near 9 or 10^{th} intercostal space

- Parietal surface - in contact with abdominal floor
- Visceral surface– related to rumen & omasum
- Greater curvature-give attachment to superficial wall of greater omentum
- Lesser curvature-give attachment to lesser omentum.
- Abomasum - very similar to the stomach of non-ruminants.
    - this is where the majority of chemical breakdown of food material occurs.
    - Mixes in digestive enzymes (***pepsin, rennin, bile, etc***.).

Small intestine

- It is a tube found between stomach & large intestine.
- Extends from the pylorus to
  - The lesser curvature of cecum in horse
  - The ascending colon in other domestic animals

Its length is about - 20m in ox

- 25 m in sheep
- 40 m in horse

Its diameter is – 7.5 – 10 cm in ox

- 2-3 cm in sheep and goat

The small intestine is divided into 3 parts

1. Duodenum
2. Jejunum
3. Ileum

Duodenum

- Part that extends from the pylorus to the jejunum
- Attached to
  - The roof of abdomen by mesodudenum
  - The liver by hepatodudenal ligament (part of omentum)
- Length is about 1m both in ox & horse.
- It forms a sigmoid loop around the pancrease-S shaped in ruminants and V shaped in horse.
- It constitutes 5% of the total length of SI.

- It has the following parts
  - Cranial part :- part which extend cranially and dorsally to the visceral surface of the liver
    - It has dilation in the horse termed duodenal ampula
  - Descending duodenum:- Part that courses caudally in the right side of the root of the mesentery
  - Cranial duodenal flexure -part (area) where the cranial part turns to course caudally as descending duodenum
  - Caudal duodenal flexure- part which turns to the left to course caudal to the root of the mesentery

- Ascending duodenum- part which courses cranially in the left side of the root of the mesentry.
- Duodenojejunal flexure - part which turns caudally to be continued by jejunum.
- Major duodenal papillae – projection on which the bile duct and pancreatic duct opens.
  - Located at a distance of 60cm, 25-40 cm & 12-15cm in ox, shoats and horse, respectively from the pylorus
- Minor duodenal papilla - projection on which the accessory pancreatic duct opens.

Jejunum

- Is the longest part of small intestine – 90% of the total length of intestine.
- It has no distinct demarcation either from duodenum or ileum.
- Attached to mesentery (mesojejunum) to dorsal body wall and it forms numerous close coils.

Ileum

- The shortest segment of the small intestine - 4.5% of the total length of SI.
- It joins small intestine to
  - The cecum in horse
  - Ascending colon in other species
- The opening where it joins the large intestine is termed ilealostium or (ileocolic orifice)

Large Intestine

- It is the part that extends from the terminal part of ileum to the anus
- It includes cecum ,colon, rectum & anal canal
- In equine LI differs from small intestine by having
  - Greater diameter
  - Saculations (haustra) allows more time for microbial digestion
  - Longitudinal bands of smooth muscle called teniae (also in pig)
  - More fixed positions
- In ruminates
  - LI don’t have significant difference from SI in its diameter size
  - No longitudinal bands (teniae) and saculations

Cecum

- A big comma shaped sac situated between ileum and colon.
- It lies in the right side of the median plane – from the right iliac to sublumbar region to the abdominal floor caudal to the xiphoid cartilage.
- It has
  - Base – initial portion which joins the colon
  - Body –middle part
  - Apex – the free blind end

- It is shortest in cat and increasingly longer in dog ,pig, ruminant & horse in that order
- Has remarkable size in equine 1.28 m long with 25-30 liters capacity, in ox 75 cm long with 8 liter capacity, in shoats 1.5lit. capacity
- The cecum of camels is similar to that of the ruminants
- It is divided into three parts
  - Ascending colon
  - Transverse colon
  - Descending colon
    - Almost similar in all species without significant difference except in horse where descending colon is saculated by longitudinal bands of smooth muscle (teniae)

a. Ascending colon

Extends from cecocolic orifice to the transverse colon.

In horse : it is often called the large colon, which has four parallel limbs and three flexures

- It has the following subparts in the sequence ingesta encounters them.
  - Right ventral colon with 4 teniae

    Collectively called ventral colon
  - Sternal flexure with 4 teniae

    Teniae are well developed and
  - Left ventral colon with 4 teniae from saculation in horse
  - Pelvic flexure with 1- 4(transition) – no saculation
  - Left dorsal colon with 1 teniae - no saculation

- Diaphragmatic flexure with 1-3 teniae are not well developed
- Right dorsal colon with 3 teniae (transition)

collectively called ventral colon

- **In ruminants** the ascending colon has the following parts
  - Proximal loop
  - Spiral loop
  - Distal loop

Proximal loop

➢Begins as direct continuation of the cecum, courses cranial up to the level of the ventral parts of the last two ribs, then turns caudal to course between descending duodenum and cecum, then runs medially cranially and ventrally to continue as first part of centripetal gyrus of the spiral loop- thus it forms a flattened sigmoid flexure before narrowing and turn ventrally to continue as centripetal gyrus.

Spiral loop

- Forms a flat coil
- It has :-
  - Two full centripetal turns (part going in toward the central flexure
  - Two full centrifugal turns (part coming back out from the central flexure

Distal loop

- Proceeds from the last centrifugal gyrus dorsally and caudally over the proximal loop to continue with the transverse which its turn is continuous with the descending colon
- **In pig**
  - The ascending colon has the same basic parts as that of the ruminants but proximal loop is absent
  - Spiral loop is arranged in an inverted ,cone shaped coil
    - Central flexure set down at the apex
    - Centripetal turns form the outside of the coil and spiral clockwise down to the central flexure as viewed dorsally

    - Centrifugal turns are inside of the centripetal turns and spirals back in counter clockwise direction
    - The centripetal turns are saculated because of the teniae and are larger in diameter than the centrifugal turns
- **Transverse colon**
  - The portion of the colon which courses from the right to the left side cranial to the roof of the mesentery
- **Descending colon**
  - Courses caudally dorsal to ascending duodenum
  - Displaced to the right side of the abdomen in ruminants, and courses under the right kidney
  - In other animals found left to the root of the mesentery
  - In ruminant forms a slight sigmoid flexure near the pelvic inlet and joins the rectum

Rectum

-Is the terminal part of the large intestine which is nearly straight

-Found mainly in the pelvic cavity

-It dilates terminally to form rectal ampula for the storage of feces in horse, dog & ox

Anus

The junction between terminal part of the alimentary canal with skin

It is guarded by two sphincters

- Internal anal sphincter (smooth muscle)
- External anal sphincter (striated muscle)

Thank you!!!

ACCESSORY DIGESTIVE ORGANS

- The accessory digestive organs include
  - Salivary gland
  - Liver
  - Pancreas
- All are exocrine glands attached to the digestive system through ducts

1. Salivary glands

- Are accessory digestive glands found in and around oral cavity
- There are three primary salivary glands whose ducts open into the mouth.
- These are :
  - Parotid salivary gland
  - Mandibular salivary gland
  - Sublingual salivary gland
- They produce saliva which
    - Lubricates chewed food
    - Moistens the oral walls
    - Contains enzyme ptyalin (amylase) which digest starch

a. Parotid salivary gland

- Located caudal to the ramus of the mandible near the base of the ear – retromandibular fossa.
- Its duct opens into the upper bucal vestibule beside upper 4^{th} premolar.

b. Mandibular salivary gland

- Found in an area that extends from atlantal fossa to the basis hyoid bone.
- Partly it is covered by parotid gland, lower jaw and muscles.
- Its ducts open to sublingual caruncle.

3. Sublingual gland

- Found under the oral mucosa between the body of the tongue and the ramus of the mandible.
- It has two parts except in the horse.

Monostomatic gland

- The ducts of which opens at the sublingual caruncle
- It is absent in horse

Polystomatic gland

- Has multiple ducts that open into the oral cavity proper

Zygomatic salivary gland

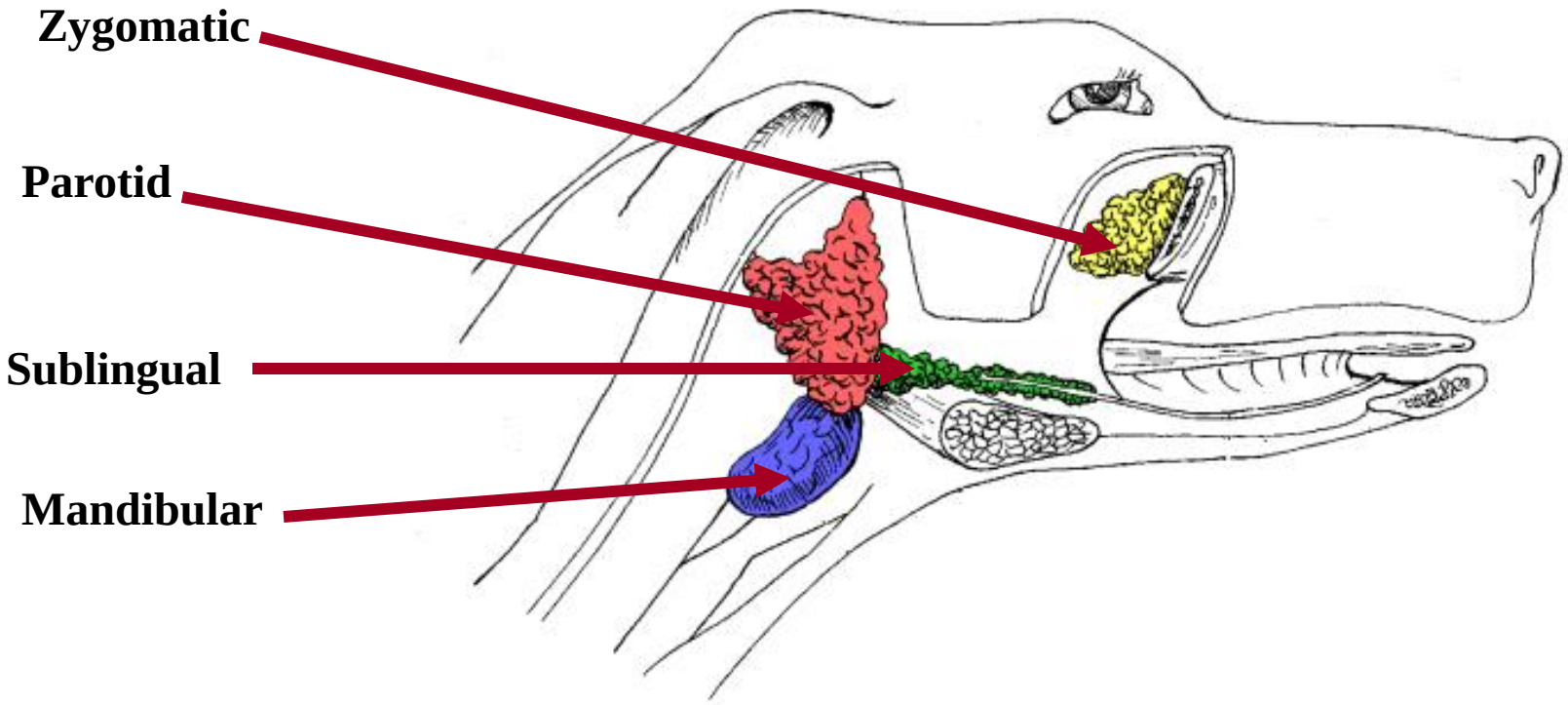
--Found in the carnivores on the upper part of the cheek medial to the zygomatic arch.

They are well developed buccal gland

-Their ducts open into the oral vestibule near the last upper cheek teeth

Monogastric Salivary Glands

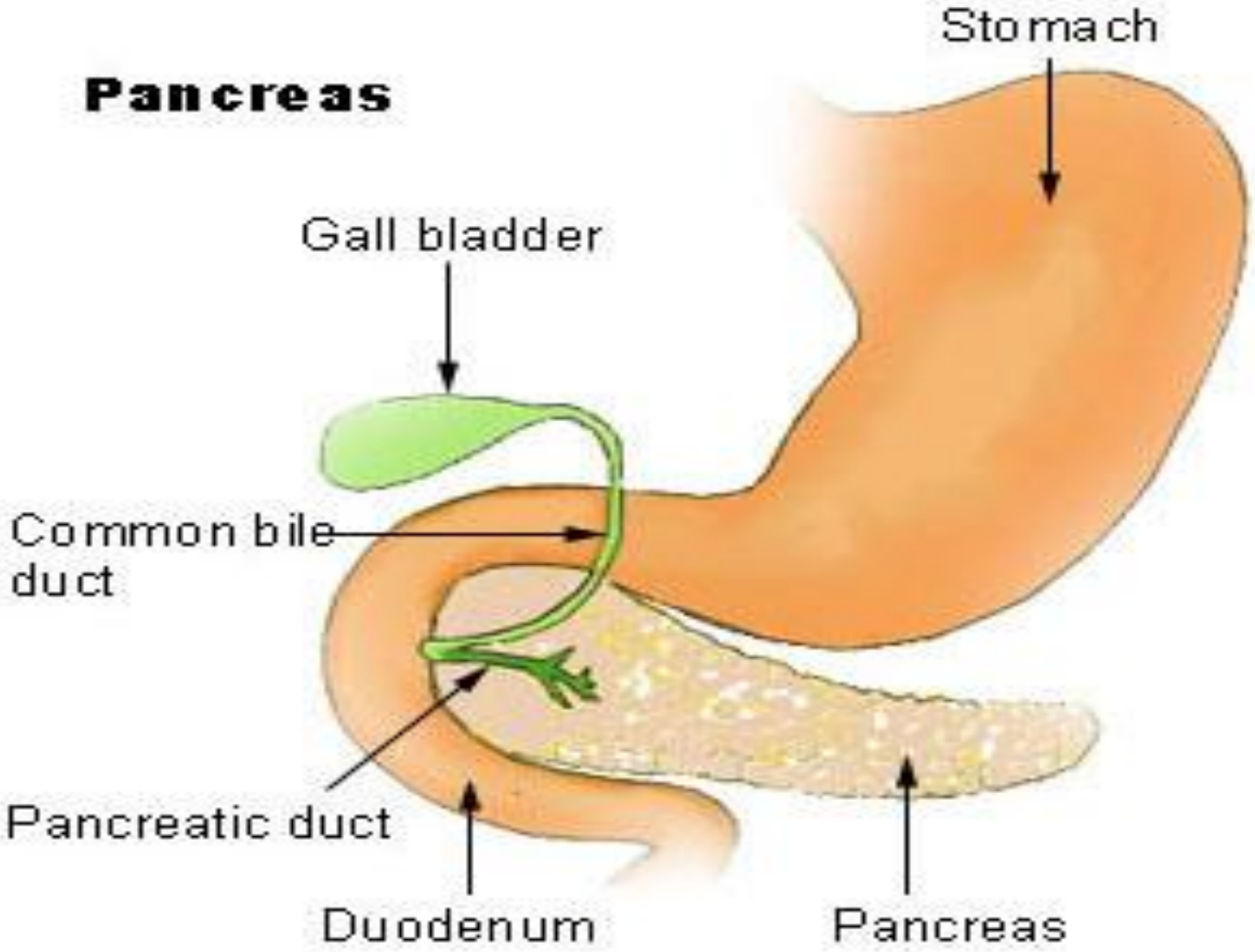
Types of Glands:

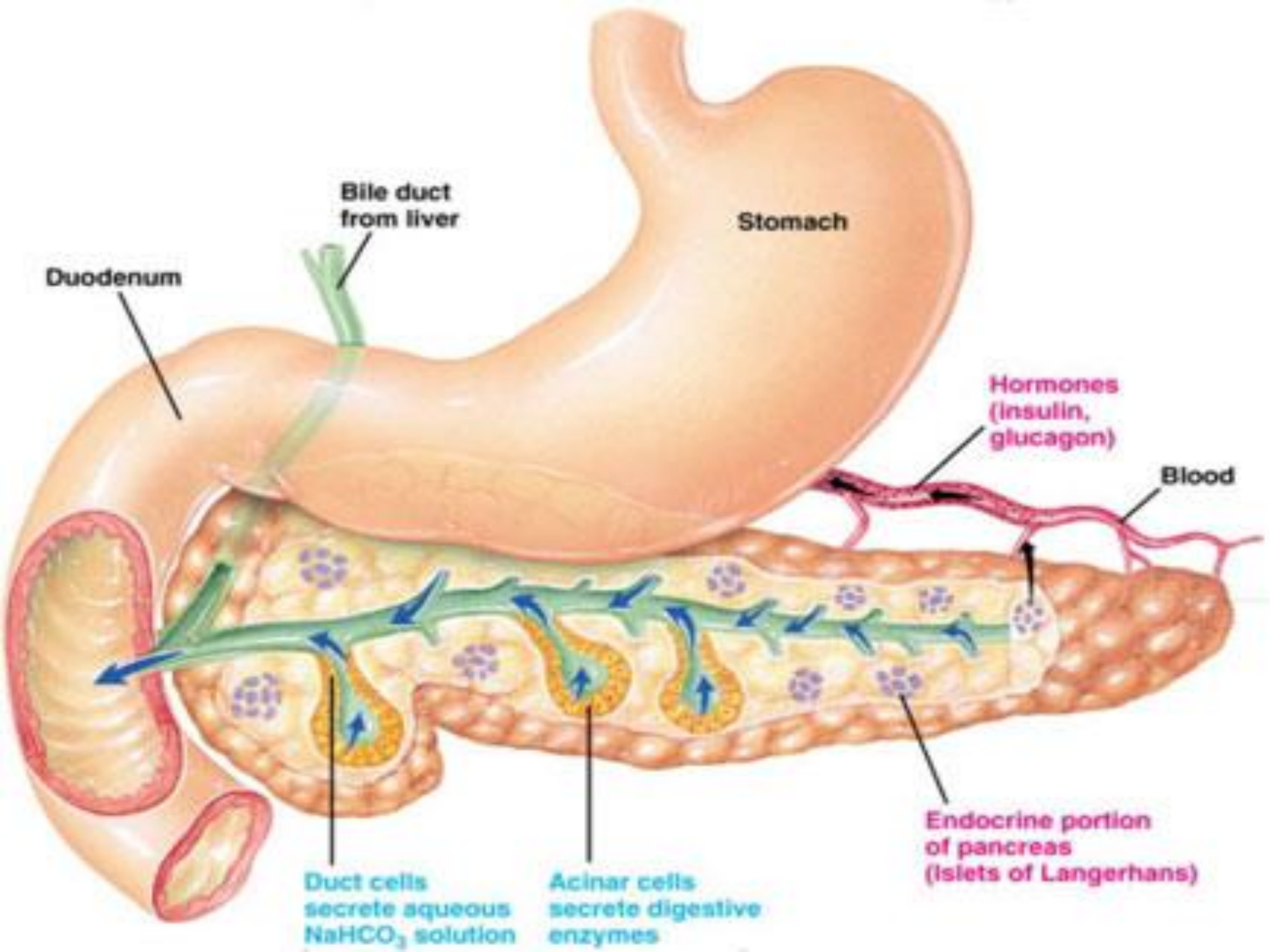


2. Pancreas

- It is a gland found in the first loop of duodenum.
- Found in the right side of the median plane.
- It has
  - Two surfaces - dorsal & ventral
  - Three borders
  - Three angles
- Dorsal surface is partially covered by peritoneum related to ventral surface of right kidney, adrenal gland, stomach and liver (right & caudate lobe).
- Ventral surface – present two impressions by base of cecum & transverse colon.

- It has two lobes and body
  - The lobes are right and left lobes
  - It has two ducts
    - Pancreatic duct (smaller) empties into the major duodenal papillae together with the bile duct
    - Accessory pancreatic duct (lager) empties into the minor duodenal papillae
- In dog and horse both pancreatic (Wirsung's) duct and accessory pancreatic (Santorini's) duct present
- In pig and ox mainly accessory pancreatic duct is present.
- In ox pancreatic duct may occasionally be present
- In cat and shoats mainly pancreatic duct is present


Pancreas
Stomach
Gall bladder
Common bile duct
Pancreatic duct
Duodenum
Pancreas


Bile duct
from liver
Stomach
Duodenum
Hormones
(insulin,
glucagon)
Blood
Endocrine portion
of pancreas
(Islets of Langerhans)
Duct cells
secrete aqueous
$NaHCO_3$ solution
Acinar cells
secrete digestive
enzymes

3. Liver

- Liver is the largest gland in the body
- It is a multipurpose organ essential to life with over 500 function
- In most species it is found in the right side of the median plane in the cranial part of the abdominal cavity immediately behind the diaphragm
- It is reddish brown in color (dark brown in camels)
- It is covered with connective tissue capsule
- The liver present
  - Two surfaces
    - Diaphragmatic
    - Visceral

- Four borders
  - Dorsal
  - Ventral
  - Right
  - Left
- Two to Seven lobes

- **The diaphragmatic surface (parietal surface)**
  - The surface adjacent to the diaphragm
  - It has a convex outline
  - It has sulcus vena cava – an indentation which partially surrounds the caudal venacava and hepatic vein

The visceral

- It is the surface adjacent to the stomach
- It is concave in its outline that faces caudally and ventrally
- Bears a number of ridges and depressions that conform to the visceral organs that lie against it.
- It presents the hepatic porta - the area where portal vein, hepatic artery and biliary ducts enter and leave the liver.

- **Borders**
  - Right border
    - Short and thick that faces caudally
    - Presents renal depression – an impression made by the right kidney and adrenal gland that formed a depression on the right and accessory process of the caudate lobe of the liver
  - Left border
    - Is thin and smooth curve that continues with the dorsal and ventral borders
  - Ventral border
    - It is thin
    - It present
      - The gall bladder fossa
        - » Depression where the gall bladder lies
      - Notch for round ligaments
        - » Vestige of umbilical vein

- Dorsal border
  - Almost median in position
  - It bears
    - Sulcus vena cava – indentation through which caudal venacava
    - Oesophageal impression –indentation formed by oesophageal

Lobes

- Left lobe
  - Part of the liver to the left of a line from esophagus to the round ligaments
  - It is divided into left lateral and left medial lobes in dog, pig and horse, but not divided in ruminants.
- Right lobe
  - Part of the liver to the right of a line from the caudal vena cava to fossa for gallbladder
  - It is divided in to right lateral and right medial lobes in dog & pig, but remain undivided in ox and horse
- Caudate lobe
  - Part of liver between right and left lobes and dorsal to the hepatic porta

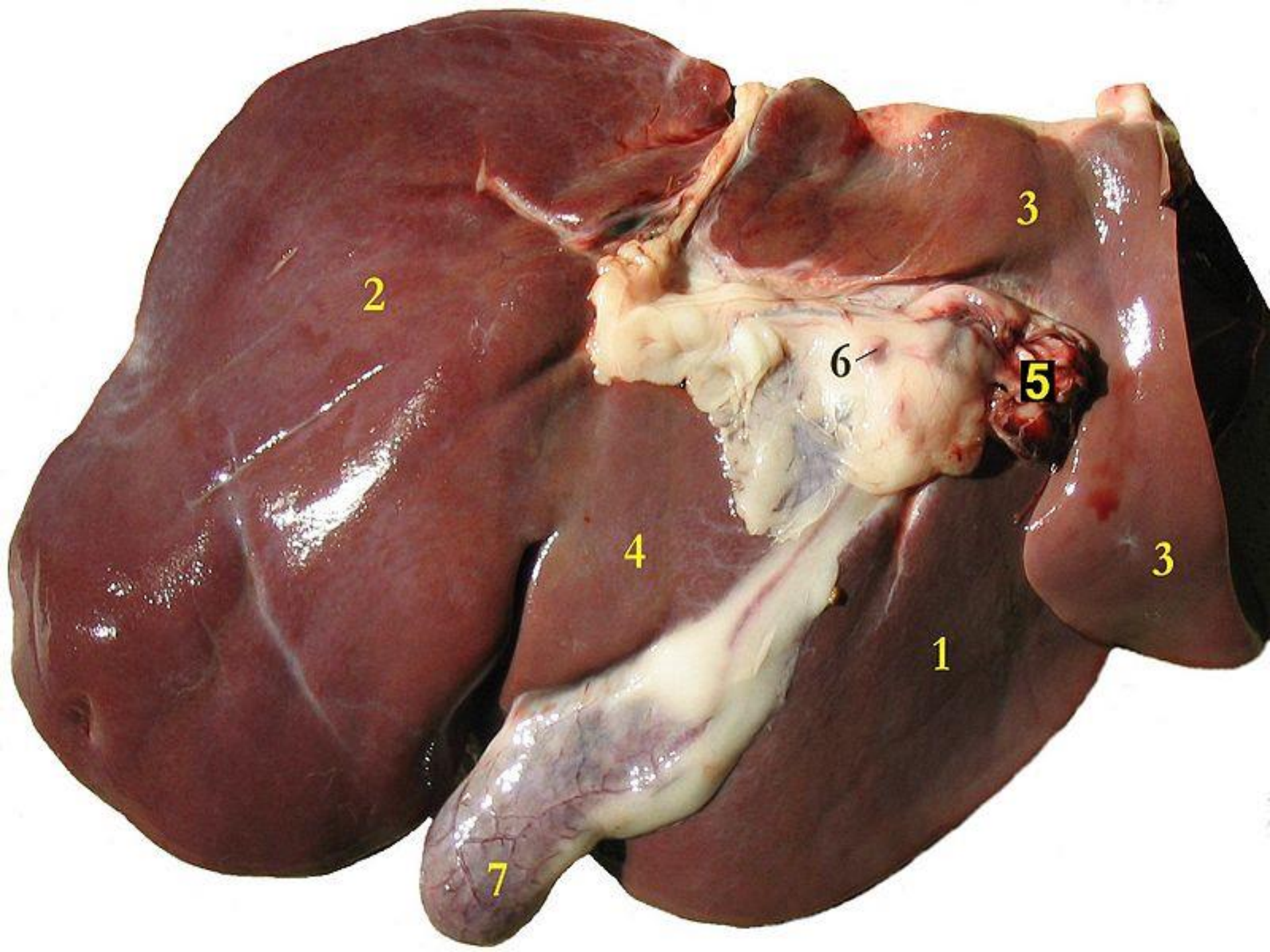
It has

- Candidate process - absent in pig and horse.
- Papillary process
  - ✓Both 1 & 2 present in dog & ox

– Quadrate lobe

- Part of the liver between the right and left lobe and ventral to the hepatic porta

* In camel the liver is only partly lobated and has left, right, quadrate & caudate lobe but there is grossly visible distinct lobulation where each and every lobule is separated by a connective tissue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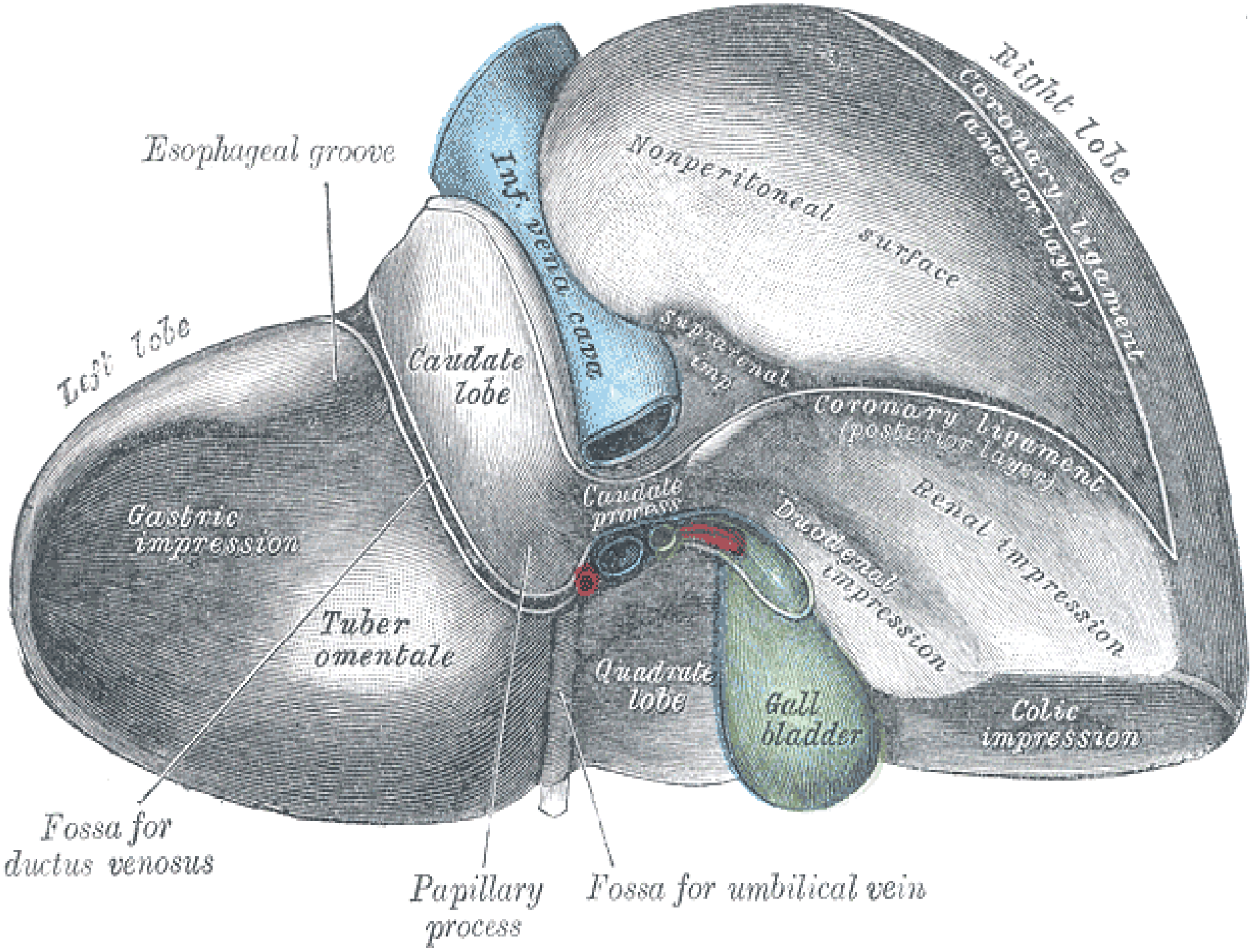

Esophageal groove
Left lobe
Caudate lobe
Inf. vena cava
Nonperitoneal surface
Right lobe
Coronary ligament (anterior layer)
Suprarenal impression
Coronary ligament (posterior layer)
Renal impression
Caudate process
Duodenal impression
Gastric impression
Tuber omentale
Quadrate lobe
Gall bladder
Colic impression
Fossa for ductus venosus
Papillary process
Fossa for umbilical vein

- Liver of a sheep:
  (1) right lobe,
  (2) left lobe,
  (3) caudate lobe,
  (4) quadrate lobe,
  (5) hepatic artery and portal vein,
  (6) hepatic lymph nodes,
  (7) gall bladder.

Surface anatomy of liver

- Liver is in contact with the abdominal wall from ventral end of 7^{th} to the last rib.
- Percussion of the liver in ox is limited to the last 4 intercostal spaces caudoventral to the lung.
- In sheep and goat -7^{th} to 9^{th} inter costal space, in camels 5^{th} to 12^{th} ribs.

Gall bladder

- It is a pear shaped sac situated between the right lobe and quadrate lobe of the liver
- absent in horse and camels
- It is partly attached and in contact with the visceral surface of the liver
- Lies largely on the abdominal wall at the ventral part of 10^{th} to 11^{th} rib
- It has fundus, body and neck

- Features to be seen with gall bladder
  - **Cystic duct** – the channel to and from the neck of the gall bladder
  - **Hepatic duct –** grossly visible biliary channels leaving the lobes of the liver
  - **Bile duct –** single biliary channels formed by cystic & hepatic ducts and courses through hepatoduodenal ligament and opens into the duodenum of the major duodenal papillae

Respiratory system

Respiratory System

Definition

- Respiratory refers to those structures involved in the exchange of gases between the blood and the external environment.
- Essential organs are the lungs in which gaseous exchange take place, the others are ancillary organs comprises the air passages.

Functions of Respiratory system

- The two primary functions are:
  - ✓Supplying oxygen to the blood and
  - ✓Removing carbondioxide from the blood.
- The secondary functions are:
  - ✓Voice production,
  - ✓Temperature regulation,
  - ✓Sensation of smell and
  - ✓Assistance in the regulation of the PH (acidosis or alkalosis) of the extracellular fluid of the body.

Embryologically,

- The pulmonary system is originated from the *endoderm*.
- The cartilaginous and muscular components of the respiratory organs are of *mesodermal* origin.

Importance: Knowing the anatomy of this system is essential in the study of the function and diseases of the organs incorporated.

The respiratory system consists of :

- Conducting portion,
- Respiratory portion and
- The pumping mechanism.

A. The conducting portion

- Includes the
  - ✓Nose and nasal cavity,
  - ✓Larynx,
  - ✓Pharynx,
  - ✓Trachea and
  - ✓The bronchi and bronchioles in the lungs.

- They conduct air into the lung but exchange of gas doesn't occur in them.

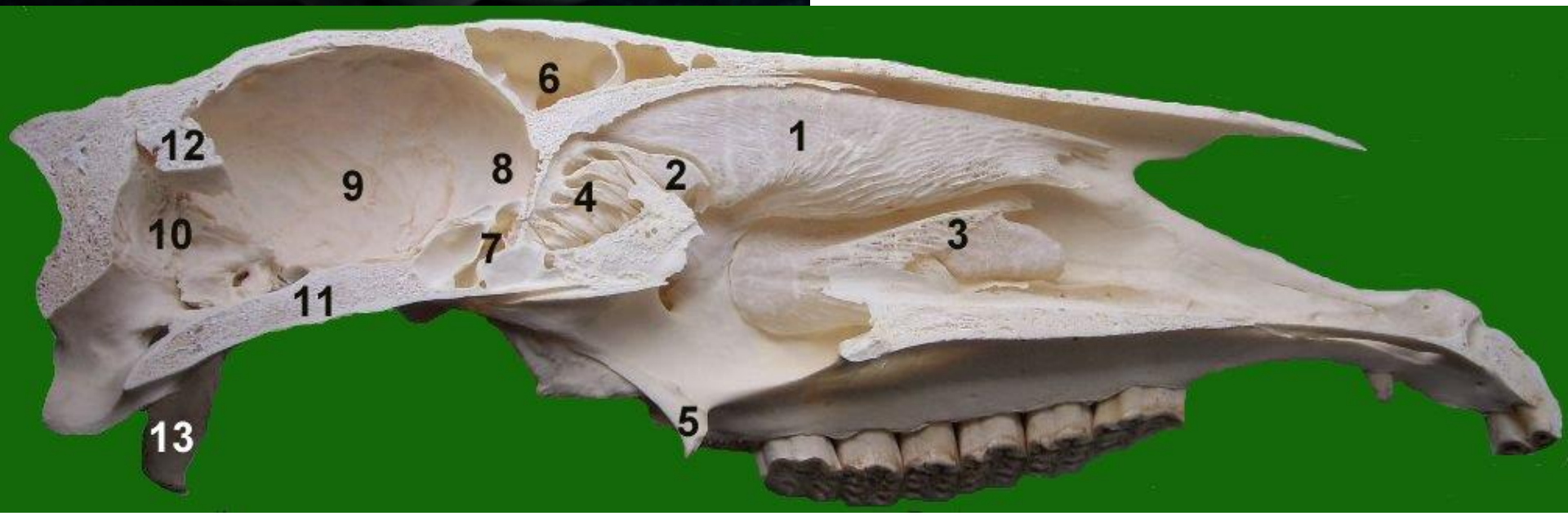
1. **The nose and the nasal cavity**

- The nose is embedded in the skeleton of the face rostral to the eye and dorsal to the mouth.
- Rostrally it consists of the external nare (**nostrils**) external opening of respiratory tract.
- The outer wall consists of the skin, muscle, bone and cartilage.
- Pig also possesses a ***rostral bone*** in the tip of its flat, disklike nose which is presumably an adaptation to the rooting habits of the pig.
- The size and shape of nose is highly variable among domestic animals.
- Variation are largely dictated by the ***nasal cartilages*** that form this most rostral end of the respiratory tract.

- The lateral aspect of the nose is covered with typical hairy skin, which contains both sebaceous and sweat glands.
- The hairless region of the most rostral parts of the nose in species other than the horse contains **no** sebaceous glands.
- But, it do have numerous sweat glands, which keep the region around the nostrils moist.
- This area is the ***planum nasale*** in the sheep and goat, ***planum rostrale*** in the pig, and ***planum nasolabiale*** in the cow.
- The equine nose lacks a planum, being instead covered with short, fine hairs.

- The lateral wall of the external nare of equine is flexible, allowing for an enormous range of diameters.
- Nostril of horse is aided by short blind-ended diverticulum lateral to the true nasal cavity which is called "***false nostril***" ***(nasal diverticulum)*** is probably aid in passive dilation of the nostrils during vigorous ventilation.
- The space in the nasal cavities are occupied by a number of scroll-like called **nasal conchae** or **turbinate bones** which arising from the bones of the lateral wall.
- The inspired air is warmed and moistened with in the nasal cavity.

- The two pairs major conchae (***dorsal concha and ventral concha***) occupy rostral parts of the nasal cavity; caudal parts are filled with ***ethmoidal conchae.***
- Nasal cavity is divided by the conchae into longitudinally arrayed nasal meatuses.
  - ✓*Dorsal nasal meatuses*: is between the dorsal concha and the roof of the nasal cavity
  - ✓*Middle nasal meatuses*: between the two conchae.
  - ✓*Ventral nasal meatuses*: is between the ventral concha and the floor of the nasal cavity.
  - ✓*Common nasal meatuses*: communicates between the others and is adjacent to the nasal septum.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- The nasal cavity is separated from the mouth by the hard and the soft palates and separated into two isolated halves by a median ***nasal septum***.
- The rostral part of the nasal septum is cartilaginous, whereas the most caudal part is created in part by a **plate of bone**.
- Each half of the nasal cavity communicates with the nostril of the same side rostrally and with the pharynx caudally by way of the ***choanae*** (*caudal nares*).

- The bones that form the walls of the nasal cavities include:
  - Frontal and nasal bones dorsally,
  - The incisive and maxillary bones ventrally and
  - The lacrimal and zygomatic bones laterally.
- The caudal and the ventral parts of the nasal septum are osseous and are formed by the perpendicular plate of the ethmoid bone and by the vomer respectively.
- The nasal cavity, the nasal septum and the nasal conchae and ethmoid bones are lined by a mucous membrane.

- The mucosa of the respiratory area has a **reddish** pink colour while that of the olfactory area appears yellowish in horses, ox and sheep, olive-brown in goats and pigs grey in dogs and cats.
- Generally the olfactory mucosa is restricted to the caudal, dorsal part of the nasal cavity.

2. Pharynx

→ Has been described in the digestive system.

3. Larynx

- Is the gatekeeper to the entrance of the trachea.
- The larynx is the cartilaginous and membranous organ that connects the caudal part of the pharynx with the trachea.
- The cavity is lined by a mucous membrane
- And is kept patent by its cartilaginous skeleton, which are attached to intrinsic and extrinsic laryngeal muscles.

The primary larynx's function are

- to regulate the size of the airway and
- to protect it by closing to prevent substances other than air from entering the trachea.

Secondary function is that the larynx is the organ of ***phonation (vocalization)***, hence its common name, **voice box**.

Laryngeal cartilage include:

- Cricoid
- Thyroid
- Epiglottic
- Arythenoid
- Corniculate and
- Cuneiform

- The first three are single while others are paired.
- The cricoids, thyroid and the main part of arthenoid cartilages are composed of **hyaline cartilage** and may ossify at old age.
- The other composed of **elastic cartilage**.

The ***Cricoid cartilage***: has signet ring shape

The cricoid cartilage articulates with

- ✓ Cranially the thyroid cartilage and the two arytenoid cartilages and
- ✓ Caudally attaches to the first cartilaginous ring of the trachea.

The ***thyroid cartilage***: is a shield shaped cartilage that consists of two plates fused ventrally forming the body.

- ✓ The in some species presents a ventral prominence, which in man is called the Adam's apple.
- ✓ The cartilage is located rostral to the cricoid to which it articulates.

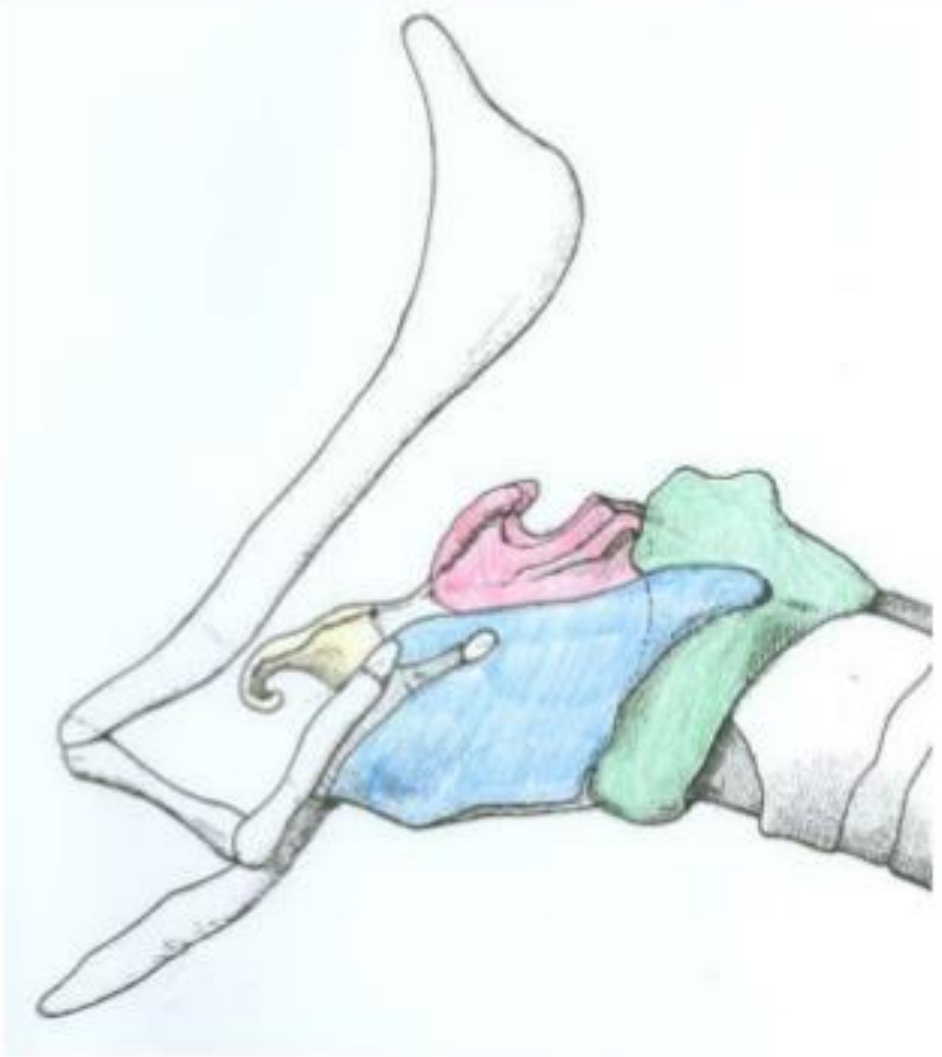
The ***arythenoid cartilage***: is ladle shaped cartilage located on either side of and rostral to the dorsal half of the cricoid cartilage.

- ✓ The arytenoid cartilages of all species have a ventral ***vocal process***, to which is attached the vocal ligament ***(vocal cord).***

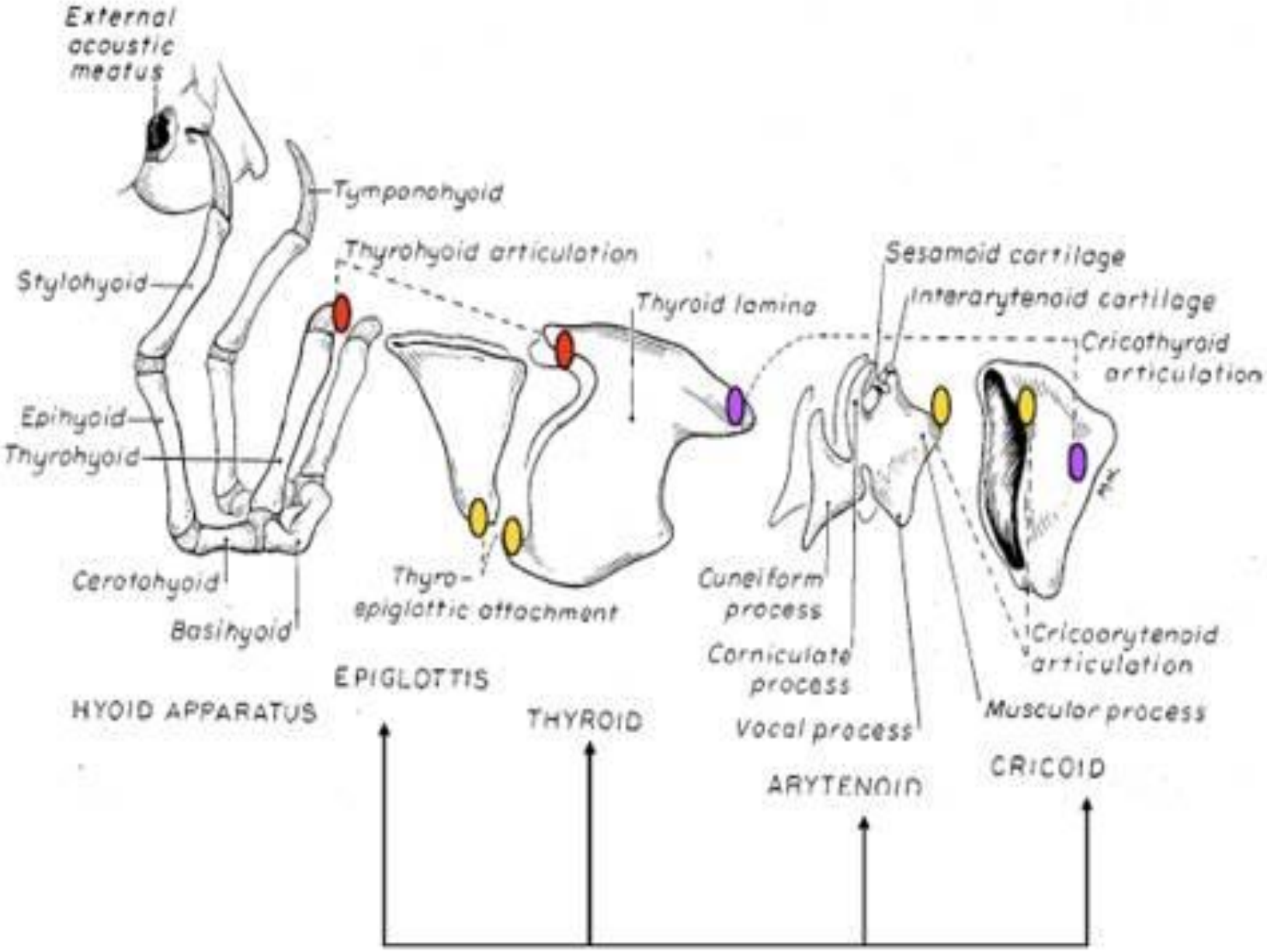
The ***cornuate cartilage*** is a cartilage with the shape of a pair of goat horns and is attached to the apex of the corresponding arythenoid cartilage.

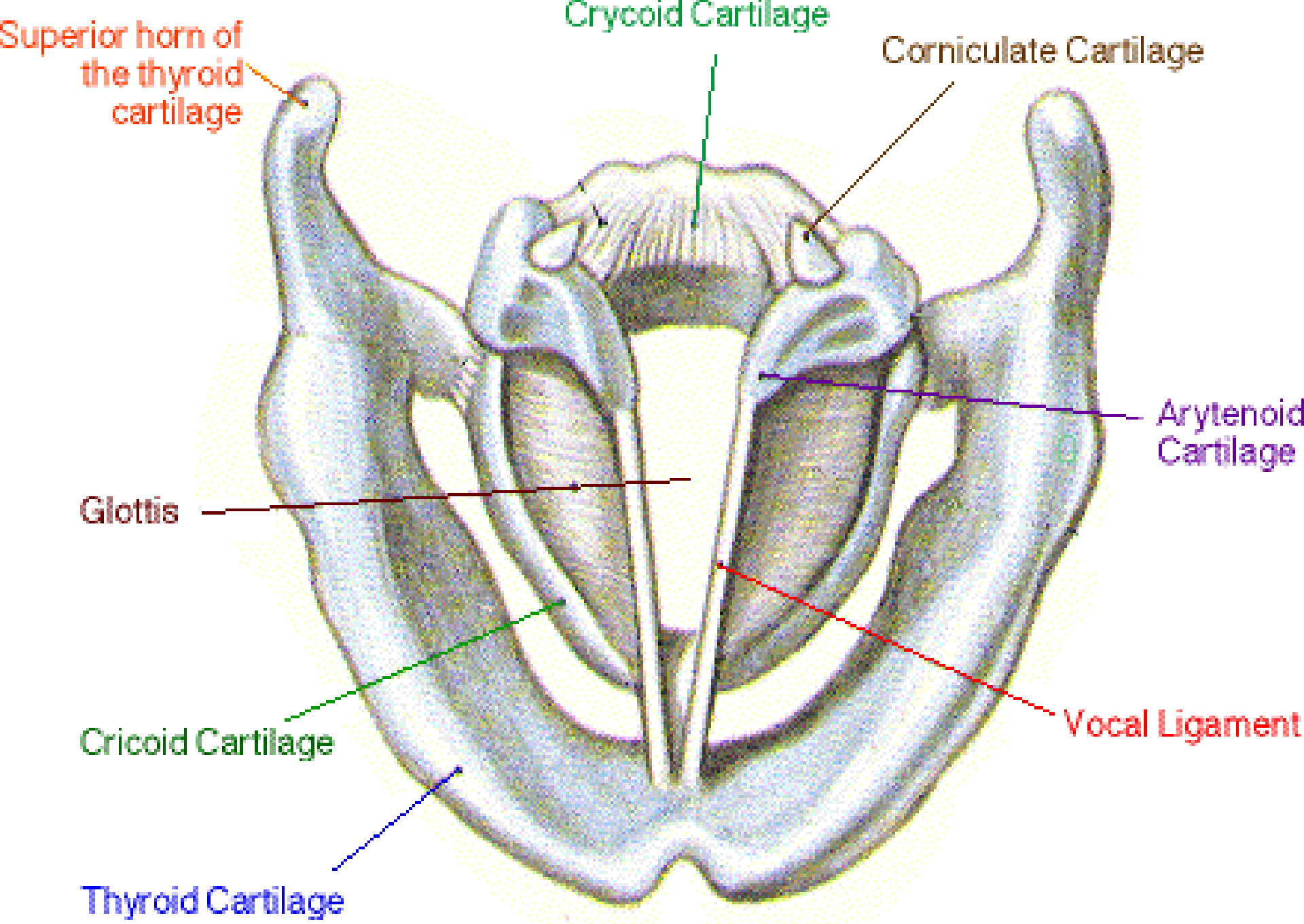
Equine Larynx

- Anatomy
  - Paired arytenoids
  - Epiglottis
  - Thyroid
  - Cricoid

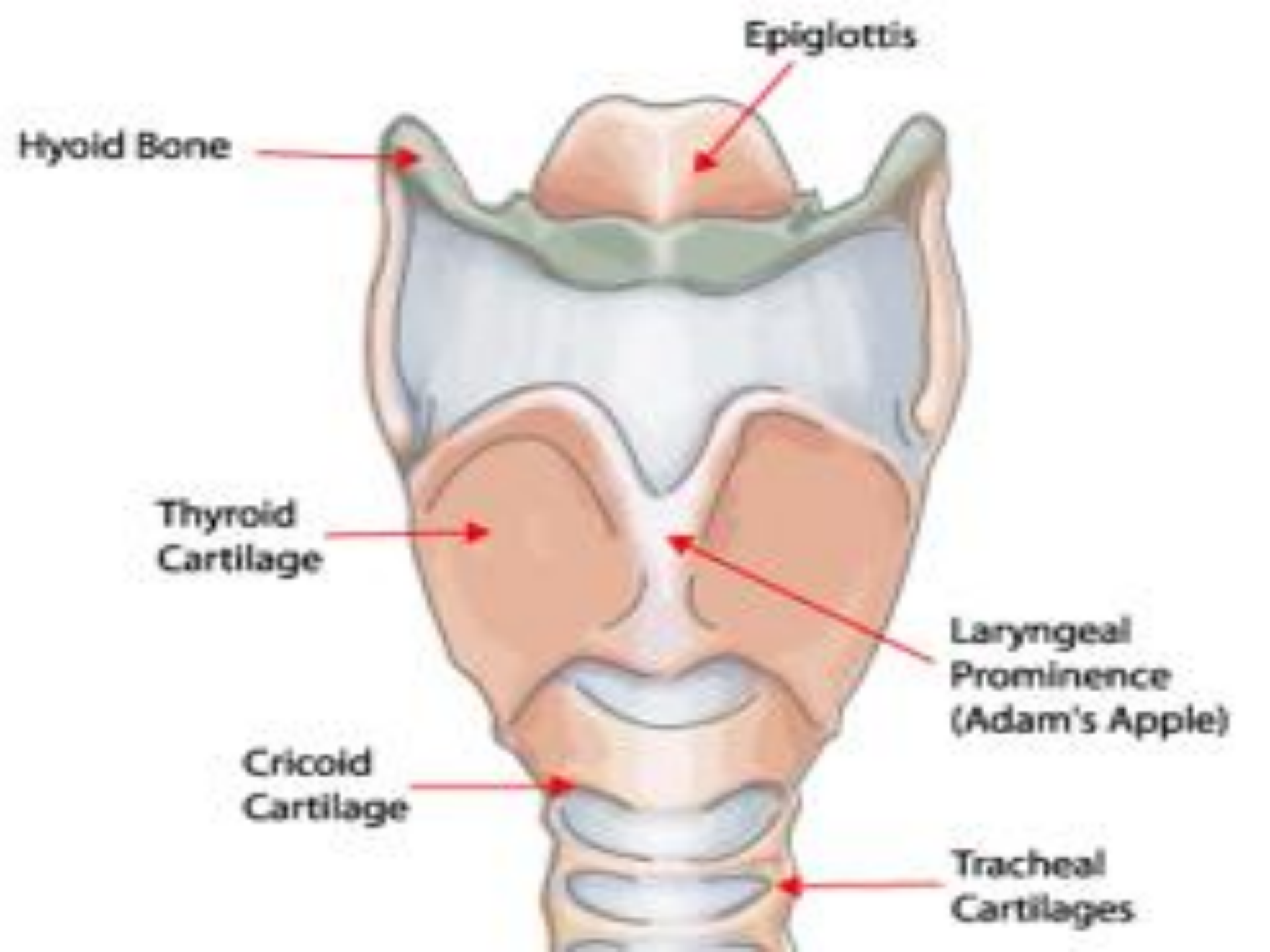


Bones of hyoid apparatus and laryngeal cartilages





The Larynx: viewed from above


Epiglottis
Hyoid Bone
Thyroid Cartilage
Laryngeal Prominence (Adam's Apple)
Cricoid Cartilage
Tracheal Cartilages

The ***epiglottic cartilage*** spade-shaped forms the core of the epiglottis.

- It is located caudal to the root of the tongue and rostral to the thyroid and arythenoid cartilages.
- During deglutition the epiglottis is pushed caudal to so that it covers the glottis and prevents the foreign materials from entering the trachea.

The ***cueiniform cartilage*** is a wegde like cartilage.

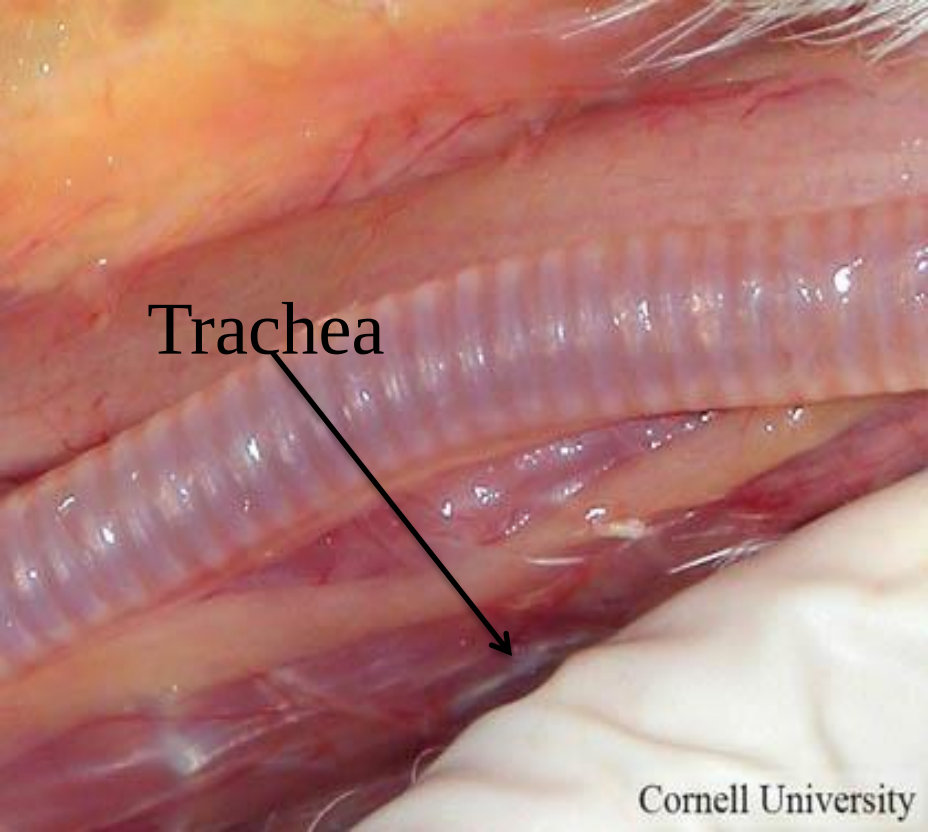
- It presents only in horses and dogs.
- It articulates with the base of the epiglottic cartilage in horses and to the arythenoid cartilage in dogs.

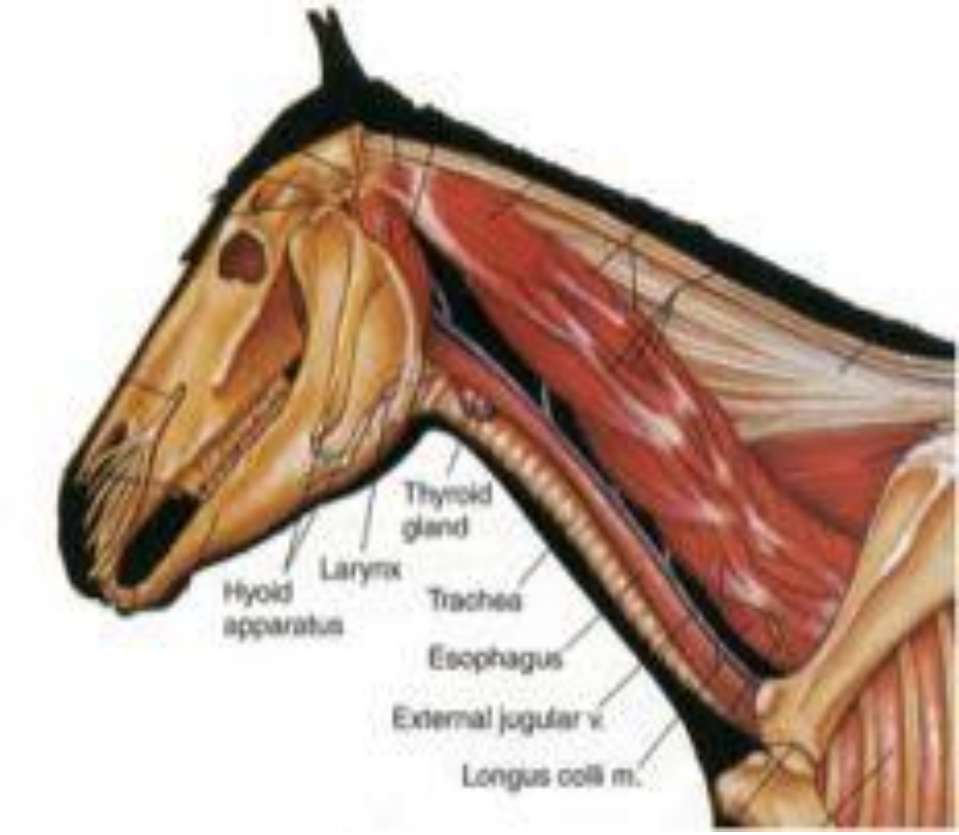
Topography of larynx:

- The larynx is ventrally located caudal to the ramus of the mandible up to the level of the second cervical vertebrae.
- It is related dorsally to the pharynx,
- Related laterally to the omohyoideus and sternomandiblaris muscles and the thyroid gland and ventrally to the sternohyoidus muscle.

4. Trachea

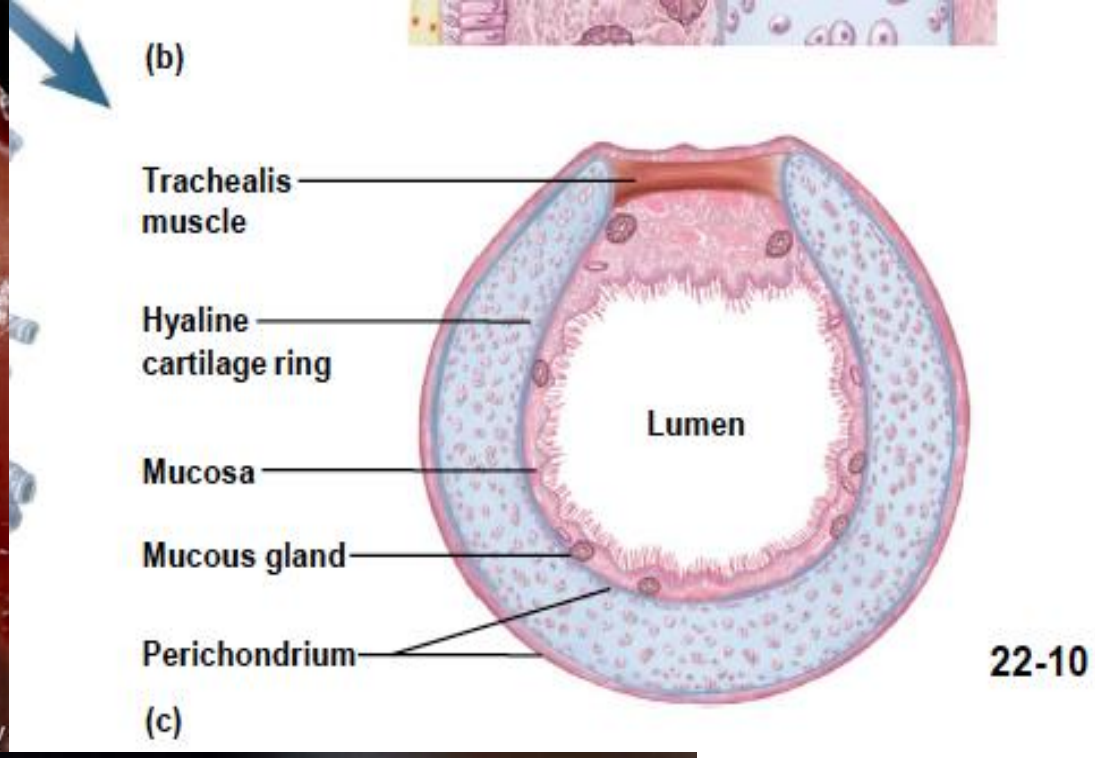
- It is the flexible membranous and cartilagous tube extending from the larynx at the level of the 1st or 2nd cervical vertebrae to the level of the 5th or 6th inter costal space.
- Then it bifurcates into the right and the left principal bronchi, just dorsal to the base of the heart.
- More or less median in position.
- It is about 70-80cm long in horse, 65cm in ox and 25cm in small ruminant.
- At about the level of the third intercoastal space, in ruminants and pig, the trachea gives off the **tracheal bronchus** from its right side.
- This bronchus ventilates the apical lobe of the right lung.


Trachea
Cornell University

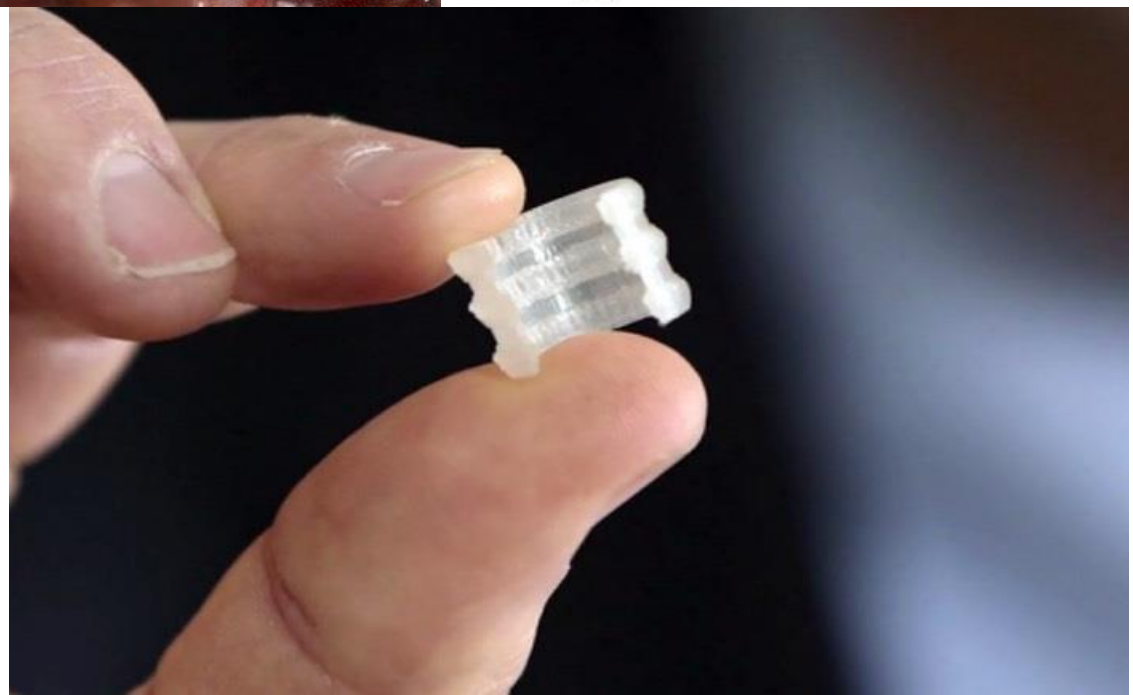

Thyroid gland
Larynx
Hyoid apparatus
Trachea
Esophagus
External jugular v.
Longus colli m.

- The wall of trachea is composed of :
  - ✓ Mucosa — inner layer
  - ✓ Fibrocartilaginous ring — middle layer and
  - ✓ Adventia (in the neck) or serosa (in the thorax) — outer layer
- Mucosal layer of trachea is lined by a ciliated, pseudostratified columnar epithelium with goblet cells.
- The goblet (mucous) cells produce a protective covering of mucus that is continuously moved toward the larynx by ciliary action of the epithelium.
- The fibrocartilaginous coat is composed of numerous strips of hyaline cartilage that bent to form “rings” that are **incomplete dorsally** where the ends may fail to meet or may overlap.

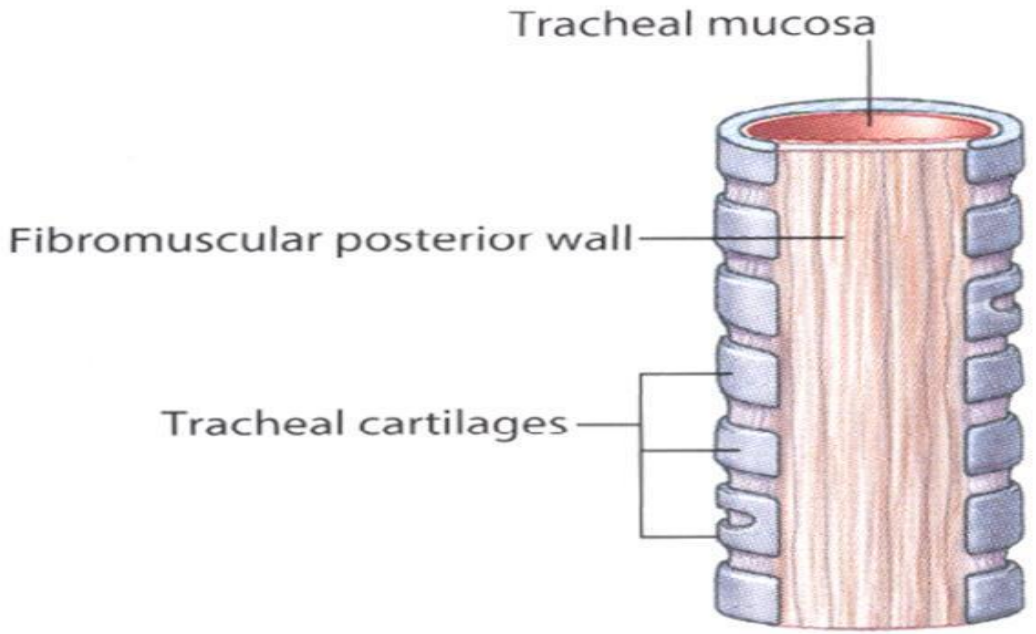

Cornell University


(b)
Trachealis muscle
Hyaline cartilage ring
Lumen
Mucosa
Mucous gland
Perichondrium
(c)

22-10



- A layer of smooth muscle called the **trachealis muscle**, is located dorsally in the trachea.
- It is positioned internal to the gap in the tracheal cartilages in the horse, pig, and ruminants.
- In the cat and dog it lies external to the gap.
- An adventitia of connective tissue completes the wall of the trachea.



Relations:

- The cervical part is related
  - dorsally to oesophagus and longus colli muscle,
  - ventrally to sternothyrohyoideus and
  - laterally sternocephalicus and omohyoideus muscles.
- The space enclosed by the divergence of sternocephalicus and the convergence of the omohyoideus is the area of election for the operation of the tracheotomy.

- Along the dorsolateral aspect of the trachea
  - The common carotid artery,
  - vagosympathetic nerve and
  - the recurrent laryngeal nerve are lie.
- It is also related to the jugular vein and thyroid gland.
- The tracheal rings are bent to form incomplete hoops or rings, which are open dorsally.
- The smooth tracheal muscles extend transversely across the dorsal part of the wall of the trachea.
- The lumen varies considerably in size as a result of the action of tracheal muscles.

Importance of structural constructions of trachea

- Cartilage of the trachea forms the rigid tube, so prevents collapsing when the lung expand.
- It has capable of expansion, so that it can accommodate any increase in the volume of air,
  - by flexible hyaline cartilage,
  - by incomplete cartilaginous plates and
  - by abundant elastic tissue in the submucosa.
- It trap and remove foreign particles by
  - The sticky mucous secretions (secreted by mucous gland) and
  - Action of cilia (which cover tracheal lumen).

- It is flexible and extensible enough to allow the movement of the head and neck and contraction of diaphragm by
  - ✓the arrangement of the rings in plates and
  - ✓the attachment of the rings by elastic tissues.
- Variations in diameter are regulated by the tracheal muscle.
- There are permanent species and regional variations in the cross-sectional form and area of trachea.
- There are also variations in numbers of rings in different species.

Trachea of Ox

- Trachea – has dorsal ridge, about 50 rings and averages about 65 cm in length.
- Diameter: 3.5–5 cm.

Trachea of horse

- Trachea longer than ox – average 75–80 cm and
- Diameter: 5 cm, 50–60 rings and no tracheal ridge.

Trachea of shoats

- Trachea similar to ox but, of course, much smaller.
- Average length 22–25 cm.
- Diameter: 1.5 cm.

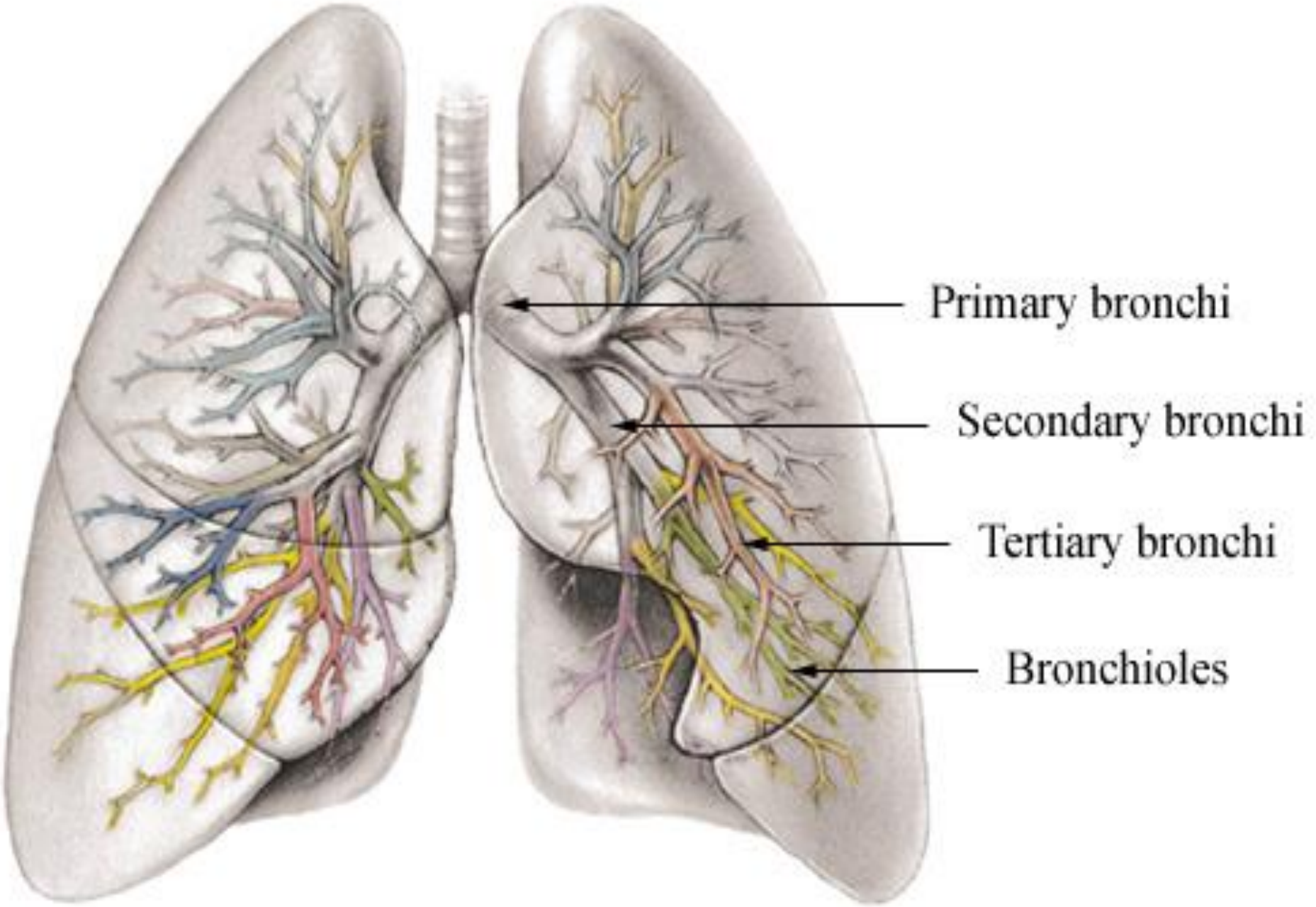
Trachea of pig

- Trachea about 15–20 cm long,
- 32–35 rings, which overlap dorsally and therefore no tracheal ridge.

5. Bronchi and bronchioles

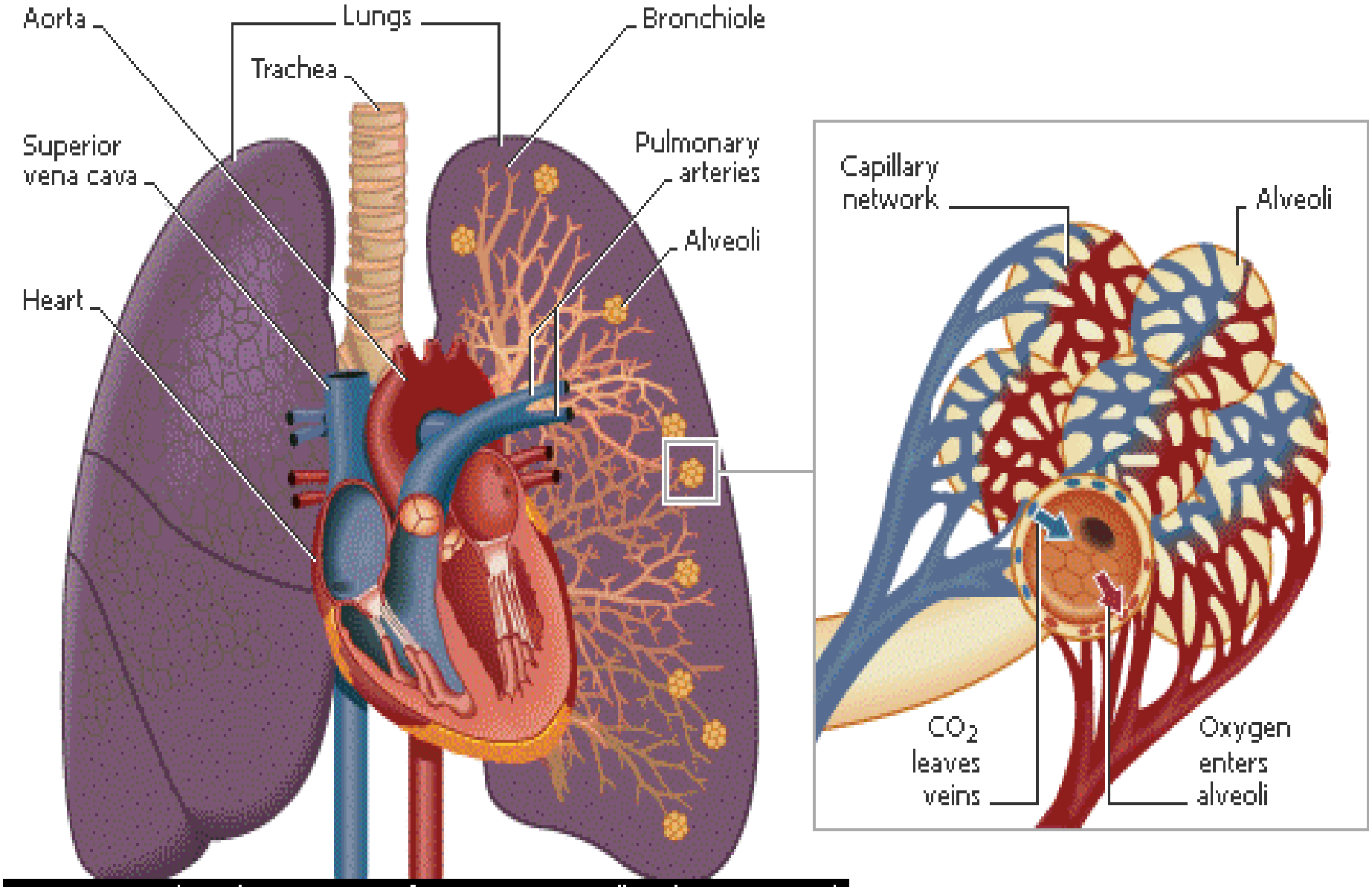
- Trachea divided into two **principal bronchi** as far as passed caudal to the base heart.
- The ruminants and pig have an additional ***tracheal bronchus*** arising cranial to the principal bronchi; it supplies the cranial lobe of the right lung.
- The principal bronchi divide into secondary, tertiary bronchi……and subsequently becoming smaller and smaller in size.
- The walls of these bronchi are supported by cartilaginous plates which is similar with that of trachea.

- When the airways divide to the extent that they are less than 1 mm in diameter, the cartilage disappears, and these airways are called ***bronchioles.***
- Bronchioles lack cartilage and glands.
- Spirally or obliquely arranged smooth muscle forms part of the wall of a bronchiole.
- The bronchiole eventually branches into several ***alveolar ducts,*** which terminate in clusters of air sacs, the ***alveoli.***
- It is here that the exchange of gases with the blood takes place.
- Some terminal bronchioles have alveoli in their walls, hence are called *respiratory bronchioles*


Primary bronchi
Secondary bronchi
Tertiary bronchi
Bronchioles

B. The respiratory portion
The lung

- The lungs are paired and right and left; respiratory organs that occupy the thoracic cavity.
- In cattle, the lungs lie within the thorax which is bounded by 13 pairs of ribs, 13 thoracic vertebrae, the sternebrae and the diaphragm.
- Each lung is covered by the pulmonary pleura in which it is free to move and suspended by its root.
- The parietal pleura are attached to the thoracic wall and contain fluid.
- Normal lungs are elastic organs, but they always contain a considerable quantity of air.
- Hence, it is in weight that can able to float on water.



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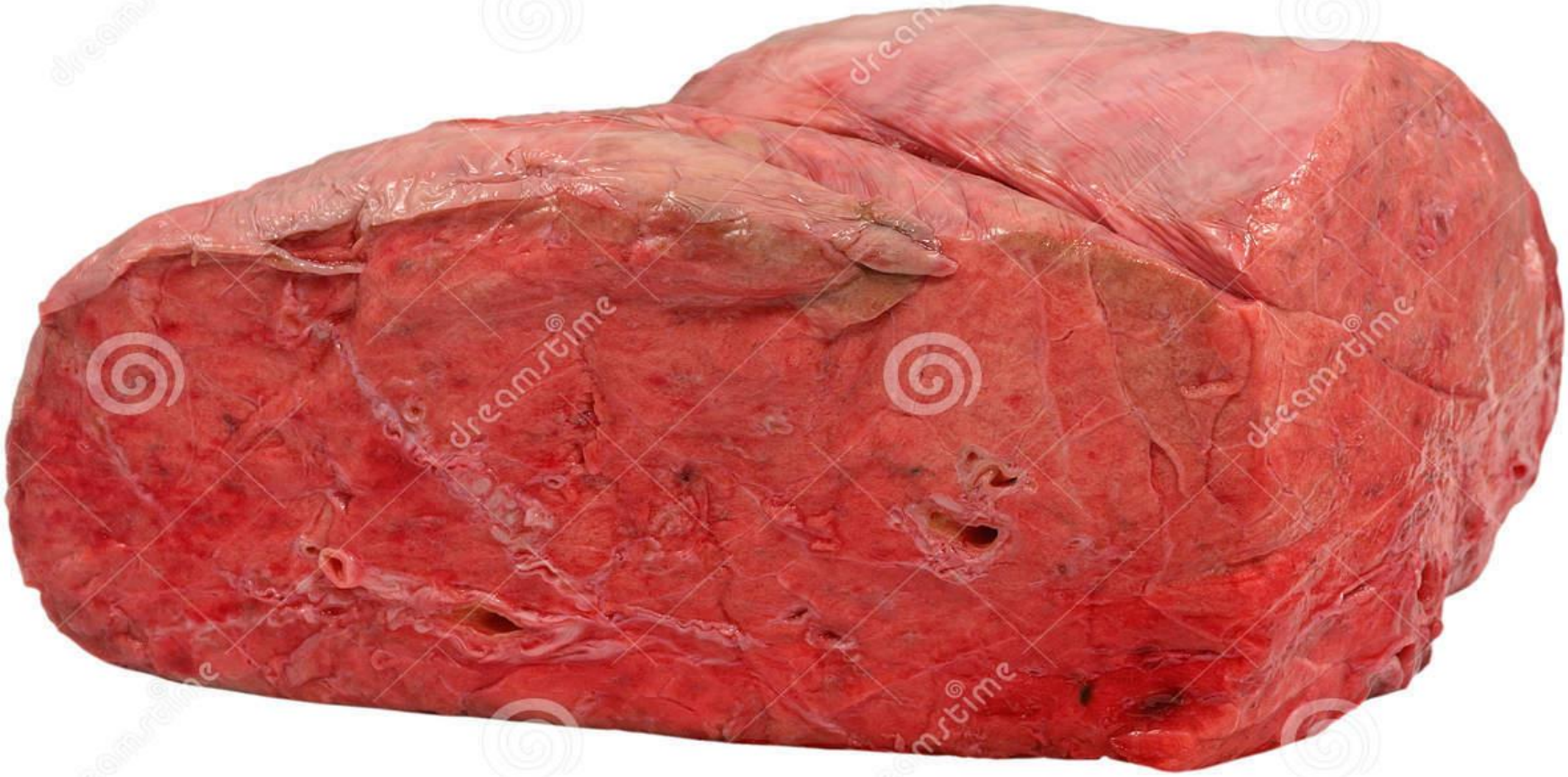
- They are soft and spongy to feel and crepitate when squeezed.
- Lungs from a foetus or a new-born that has not breathed are firmer to feel and will not float and purple in colour.
- Healthy lungs in farm animals in rural areas are **pale pink** in colour.
- Lungs that are filled with fluid as a result of a disease process will not float.
- When the thoracic cavity is opened, the lungs collapse to about one-third of their original size.
- Lungs in most species are divided into lobes.



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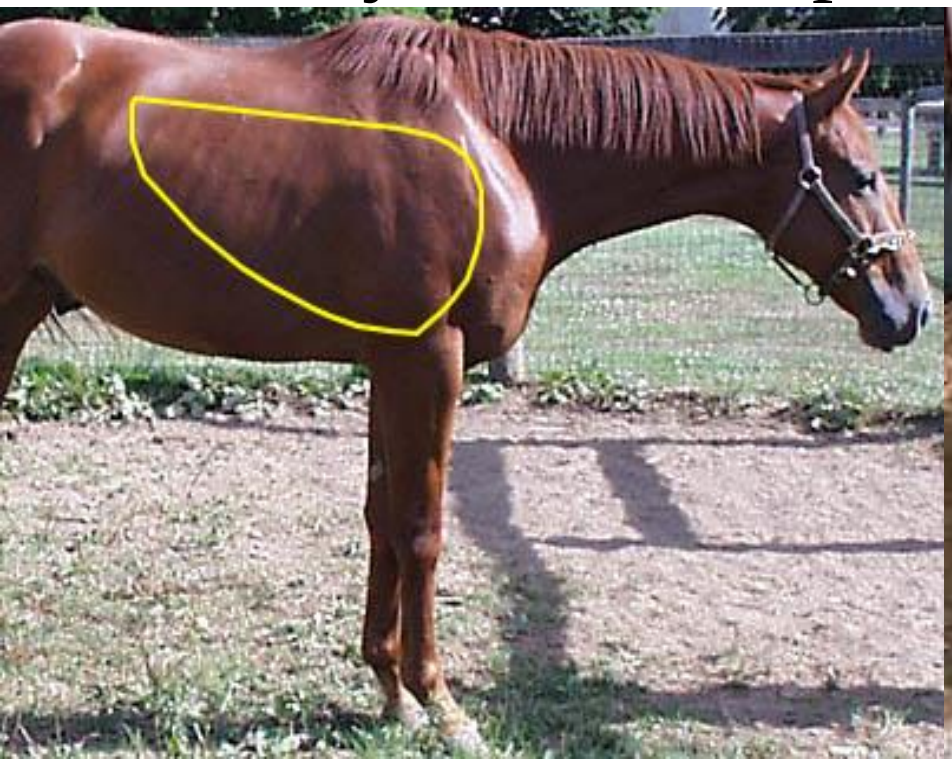
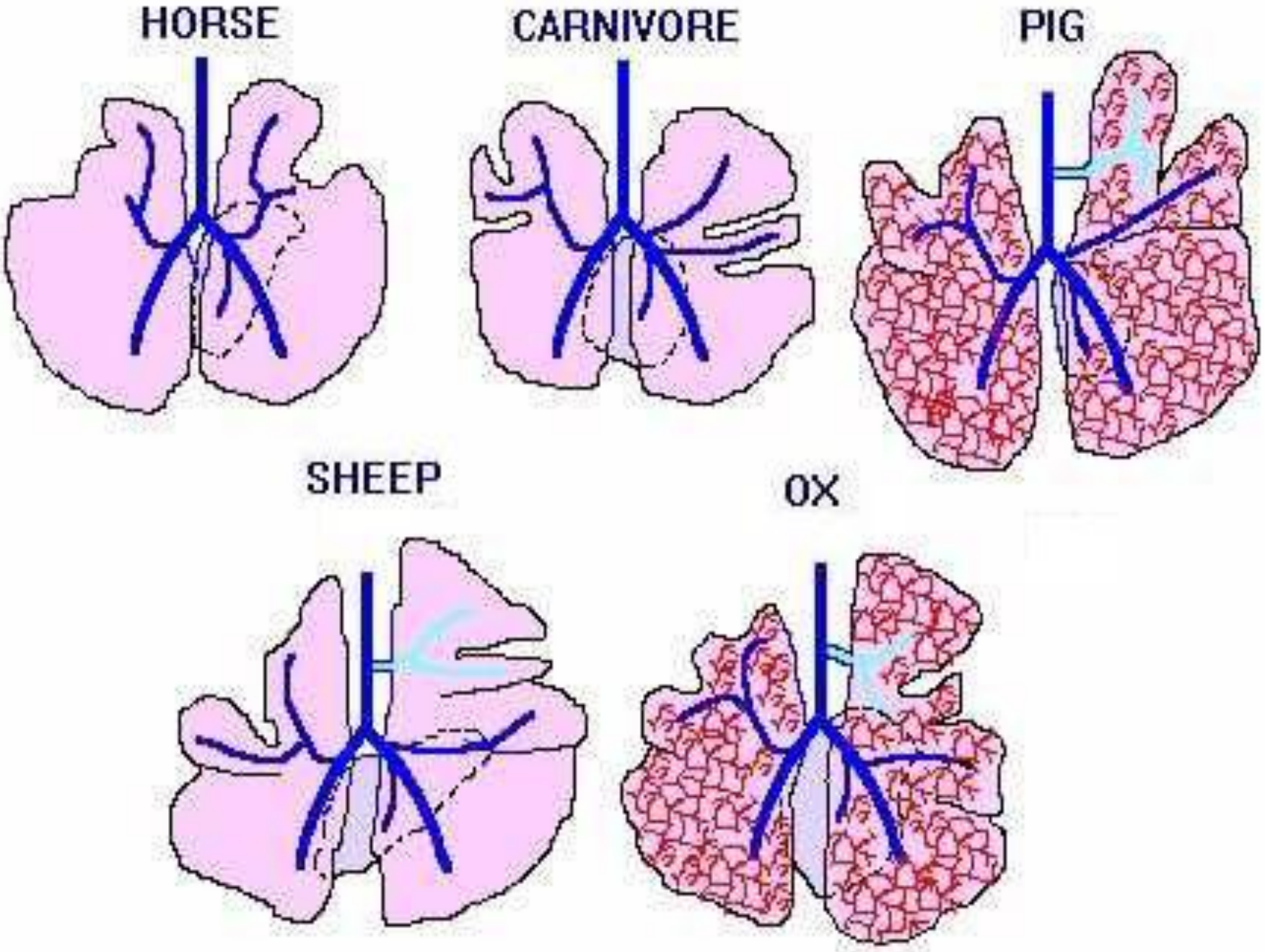
Lungs are located in the triangular area on the lateral side of chest which is called **lung area** which the angles of the area touches:

- Cranially- cuadal angle of scapula,
- Caudally- the 2nd from the last intercostal space
- Ventrally- olecranon process of ulna



A lung (pulmonary) lobe is defined as a large portion of pulmonary tissue, which is ventilated by a large bronchus arising either from the principal bronchus or from the trachea and, which is separated from adjacent lobes by **a fissure**.

SPECIES	LEFT LUNG	RIGHT LUNG
Carnivores	Divided cranial Caudal	Cranial Middle Caudal Accessory
Pig	Divided cranial Caudal	Cranial (tracheal bronchus) Middle Caudal Accessory
Ruminant	Divided cranial Caudal	Divided cranial (tracheal bronchus) Middle Caudal Accessory
Horse	Cranial Caudal	Cranial Caudal Accessory


HORSE
CARNIVORE
PIG
SHEEP
OX

In Horses:

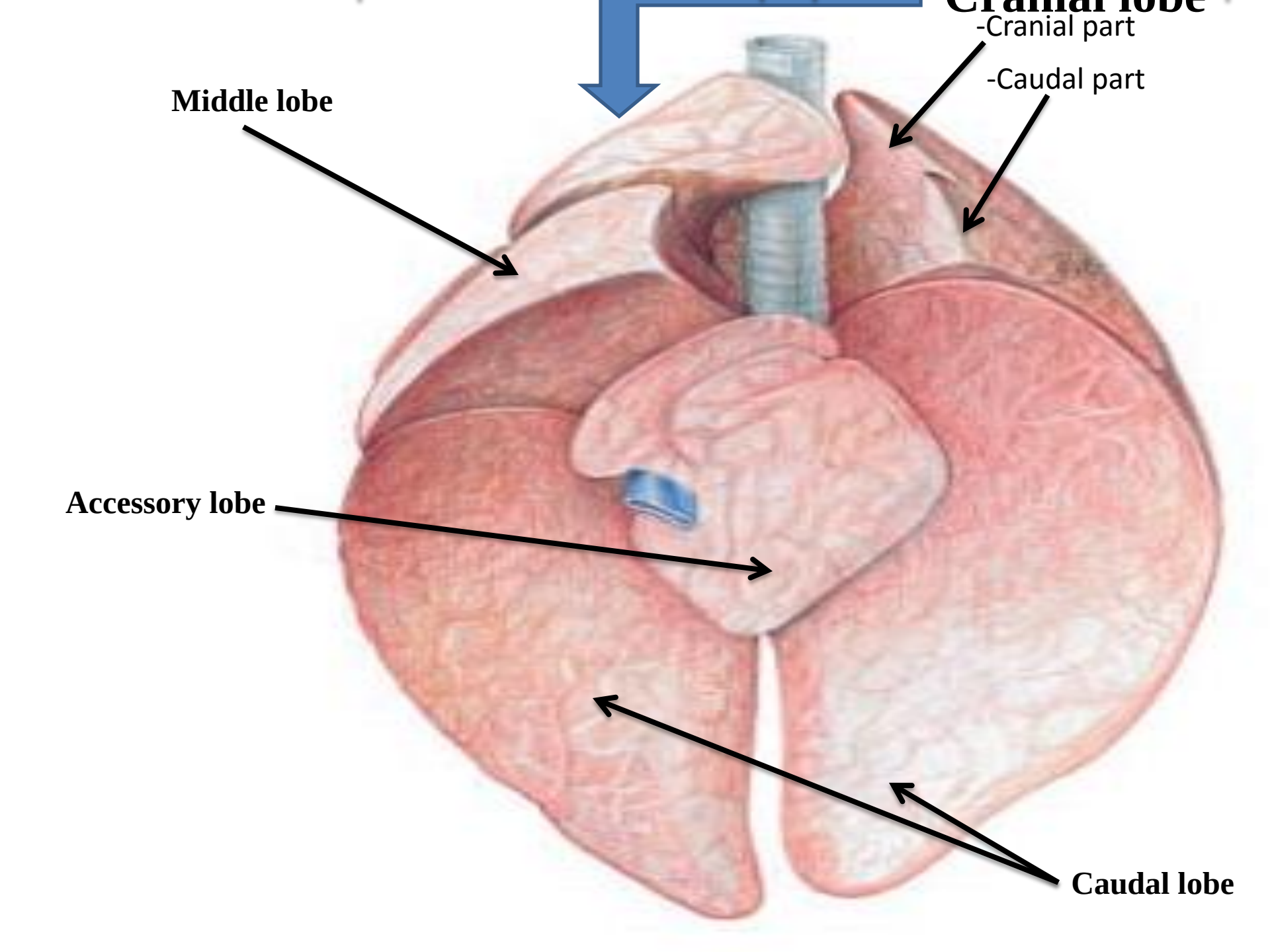
- The lungs are not clearly subdivided by deep interlobular fissure into lobes.
- But for description it can be considered that:
  - The left lung has the apical or cranial and diaphragmatic or the caudal lobes.
  - The right lung has the apical, diaphragmatic and the accessory lobes.
- The right and left lungs are about equal in length.
- No accessory bronchus.
- No surface lobulation.
- Much longer than ox.
- Weight variable.

- In the camel:
  - The lungs are characterized by the absence of the fissures and resemble those of the equidae.
  - Each lung has cranial and caudal lobes and the right lung has an accessory lobe in addition.
  - Lobulation is not distinct although on closer examination small lobules separated by connective tissue are clearly visible.
- In ruminants and pig:
  - The lungs are chiefly subdivided into by interlobar fissures.
  - There are four lobes in the right lung in all domestic animals except in horses and camels.
  - These are the apical, middle (cardiac), accessory (intermediate) and the diaphragmatic (caudal) lobes.

- The left lung has the apical and diaphragmatic lobes.
- In these species the right lung is almost twice as large as left lung because the former has an extra lobe (the middle lobe) and also its apical lobe is much larger than its left counterpart.
- Right accessory bronchus going to the apical lobe.
- Lung lobulation well marked in ox and pig.
- Weight 2.5–3 kg in ox, 350–450 g in pig and in shoat 350 g to 1 kg.
- Very compressible in pig and more dense and leathery to the touch in ruminants.

- Generally each lung of domestic animals other than poultry presents for description
  - ✓a caudal base,
  - ✓a cranial apex,
  - ✓two surfaces: costal and medial and
  - ✓three borders: dorsal, ventral and basal.
- The *base* is related to the diaphragm
  - Semilunar and concave.
  - Rests on dome of Diaphragm.
  - Right sided dome is higher than left

- The *apex* is free, blunt, laterally flattened and occupies the space at the cranial aperture of the thorax (*cupula pleurae*).
- The costal surface is the largest surface; convex and smooth in conformity with its relationship to the inner surface of the ribs, the costal cartilages and intercostals cartilages and intercostals muscles.
- It is in contact with costal pleura and overlying thoracic wall.


Cranial lobe
-Cranial part
-Caudal part
Middle lobe
Accessory lobe
Caudal lobe

The ***medial surface*** has two parts.

- ✓*A small vertebral part* related to the bodies of the thoracic vertebrae and a larger mediastinal part related to the mediastinum.
- ✓*Cranially the mediastinal part* has a well-marked concave area related to the heart and is known as the ***cardiac impression***.
- ✓The cardiac impression is much deeper and more extensive in the right lung than in the left lung.

The ***ventral border*** is sharp and irregular.

- ✓In the right lung this border is indented at the level of the heart to form the cardiac notch.
- ✓In the left lung, the ventral border is “L” shaped with the angle of the “L” forming the **cardiac notch**.

Basal border

- Thin and sharp
- It separates the base of lung from the costal surface and extends into phrenicocostal sinus.

Dorsal border

- Thick and ill defined
- Fits into deep paravertebral gutter.

THANK YOU!!!