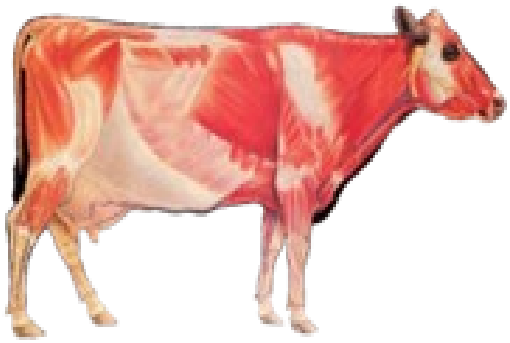
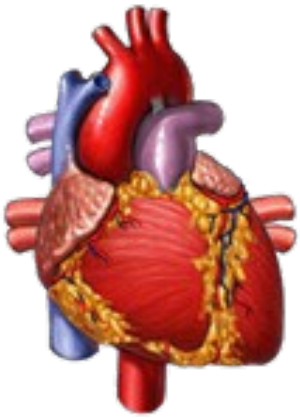
COURSE OVERVIEW

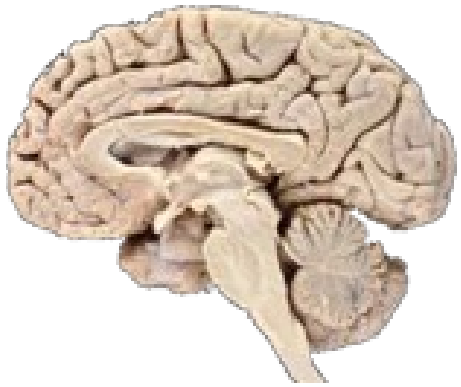
Welcome and thanks to visit this e-course on **VAN 121 - GROSS ANATOMY-II** as you will understand that you are learning the most interesting chapters of Gross Anatomy i.e the strongest part of your body framework - **MUSCLE**, the most intelligent **BRAIN** that we possess, structure of the most lovable sweet **HEART**, and the sweet**SENSES** which we have to taste, smell, hear and feel the whole beautiful world around us.

Before we overview the course, one should know that this web material which you are going to browse is a wonderful study material with brief text descriptions, colorful illustrations, animations, audio and videoclippings, glossary and quiz sections, that gives an additional support to the learner who wants to study anatomy with ease. For more detail information and an indepth knowledge about this subject you can visit the Anatomy library

VAN 121-Gross anatomy-II briefs you about the detail structure of the muscular system (**MYOLOGY**), Brain, spinal cord, cranial and spinal nerves and their innervation (**NEUROLOGY**), circulatory apparatus and its distribution, venous drainage and lymphatics (**ANGIOLOGY**), and sense organs like the eye, ear, nose, tongue and skin(**AESTHESIOLOGY**). You can navigate to any content you prefer but do not fail to see all of them.

There are 34 theory lessons and 34 practical modules for you to study.In addition this course material consist of a quiz test comprising of multiple choice questions, true or false questions and matching the correct words at the end of each lesson which should be taken up without fail.You have been supported with a glossary and a question bank too at the end of theory lessons.

	
Myology is the branch of gross anatomy which deals with the passive locomotor apparatus - the muscles, its origin, insertion and action	**Angiology** is that branch of systematic anatomy, which deals with the organs of circulation. The circulatory apparatus comprises of heart and blood vessels

	
Neurology is that branch of systematic anatomy, which deals with the structure of brain, spinal cord, cranial nerves, spinal nerves and autonomic nervous system	**Aesthesiology** is the study of special sense organs such as the eye, ear, nose, tongue and integument

MYOLOGY

- Myology deals with the study of muscles (musculi) and their accessory structures such as the fasciae and synovial membranes
- The muscles are highly specialized organs, which have the property of contracting under the influence of a stimulus

- This is termed as *contractibility* and this phenomenon helps them to move those parts of the body to which they are attached
- They are the active part of the locomotion. Sylvius is the anthropotomist, who first named the muscles
- There are three different types of muscles that make up the muscular system viz.,
    - Skeletal muscle
    - Smooth muscle
    - Cardiac muscle
- The accessory strucutres of the muscle are
    - Fascia
        - Superficial fascia
        - Deep fascia
    - Synovial membranes
        - Synovial bursa
        - Tendon sheath

CLASSIFICATION OF MUSCLES

- The muscles are classified based on the structure in to three types as
        - Skeletal muscle
        - Smooth muscle
        - Cardiac muscle
- The muscles are classified based on the function in to two types as
        - Voluntary muscle
        - Involuntary muscle

SKELETAL / STRIATED MUSCLES

- They are both directly or indirectly attached to the skeleton and hence often named as skeletal muscles
- Striated muscle is composed of long, unbranched muscle fibres, which shows cross striations under a microscope; hence it is called as striated muscle
- Contraction of this striated muscle occurs as per the will of the animal. Hence, they are also named as voluntary muscles
- Morphologically, each muscle is considered as individual organs made up of several muscle fibres. There are about 200-250 paired and few unpaired muscles present in the domestic mammals.
- A delicate connective tissue sheath, the endomycium surrounds each muscle fibre. Several muscle fibres grouped together to form fasciculus, which is covered by perimycium.
- A muscle as a whole is composed of many fasciculi and is surrounded by epimycium**,** which is closely associated with the fascia and sometimes fused with it.
- Each muscle consists of a central portion called *belly* and *two ends*
- Each end of the muscle is attached to bone or cartilage or to skin by means of either *tendon* or *ligament*
- When a muscle contracts and shortens, one end of its attachments usually remains fixed and the other end alone moves
- The fixed attachment is called origin; the movable one is called insertion. In the limbs, the more distal parts are usually mobile. Therefore, the distal attachment is usually called the insertion

Tendon

- A narrow band of white fibrous tissue that attaches muscle to bone or cartilage or other tissues is known as tendon
- Instead, some muscles are connected to bone or other muscles by a broad sheet of fibrous connective tissue called aponeurosis, which is often glistening. E.g. Linea alba.

Blood and nerve supply

- The muscle tissue is richly supplied with blood. Large arteries are accompanied by the veins and lymphatics
- The lymph vessels are few
- The nerve fibre reaches the muscle fibres and terminates into ramified expansions and is termed as end plates
- The nerves supplying the muscles are sensory and vasomotor
- Voluntary muscles are named according to the physical characteristics as follows:

Colour

- Based on the colour the striated muscles are classified into two types; red and white muscles
- The difference in colour is due to the amount of myoglobin and cytochrome in the muscle cell
- The red muscle is found in areas, which perform sustained and continuous work and are generally situated at the deeper aspect of the body whereas white muscles are found in areas, which perform quick and intermittent movement and located superficially

Action

- According to the force of action, the muscles are classified as spurt muscles which provide acceleration motion to the joints. E.g. brachialis and shunt muscles which provide stabilizing centripetal force on a joint. E.g. flexor carpi radialis
- A portion of muscle name is often related to its function. Muscles that flex the joints are named flexors. E.g. flexor carpi radialis
- Muscles that extend the joint are named extensors. E.g. extensor carpi radialis

Shape

- A muscle's name can reflect its distinctive shape. E.g. deltoideus. The term 'deltoid' means triangular shaped structure

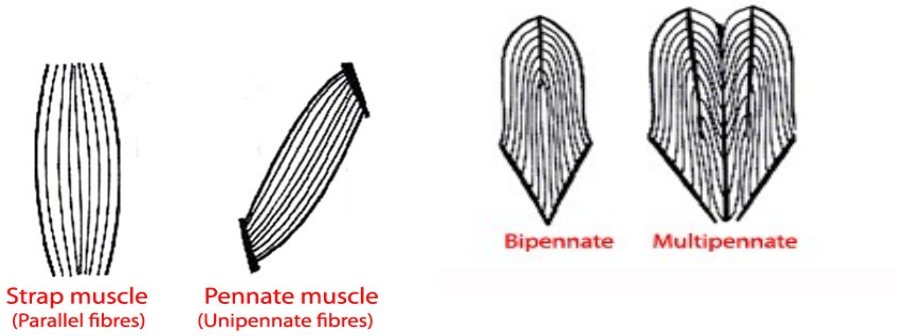
Location

- A muscle's name can indicate its physical location in the body. E.g. biceps brachii, the muscle that is located in the brachial (arm) region

Direction of muscle fibres

According to the direction of fibres the muscles are divided into

- *Parallel muscles* where the fibres are long and are placed parallel to the line of pull. E.g. biceps brachii
- Pennate muscles the muscle fibres are short and attached to the tendon at acute angle. This arrangement is known as pennate arrangement. They may be unipennate, bipennate and multipennate etc., according to the direction of the fibres in relation to the tendons. E.g. deltoid
- *Spiral muscle:* the fibres are arranged in a twisted manner. E.g. brachialis-helps rotational movements
- *Cruciate muscles:* in these muscles the fibres are arranged in superficial and deep plane, crossing like 'X'. E.g. masseter
- *Rectus and oblique muscles:* The muscle fibres that run straight in lengthwise are named as rectus.E.g. rectus abdominis. Some muscle fibres run in an obilique direction.E.g. obliquus abdominis



Number of heads / divisions

- This refers to the number of attachment sites that a muscle has at its origin.E.g. biceps brachii, a muscle having two heads of origin

Attachment Sites

- Origin and insertions are used to name some muscles E.g. sterno-cephalicus. The origin of this muscle is sternum and insertion towards the head (cephalic)

SMOOTH MUSCLE

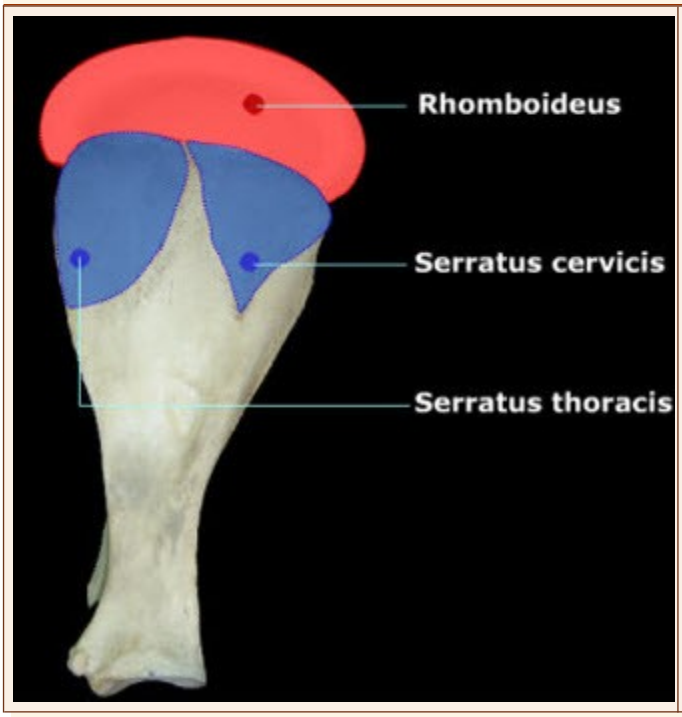
- Smooth muscle is also called as non-striated or involuntary muscle, because the contraction of the muscle is not controlled by the will of the animal
- The muscle fibres don't show cross striations under microscope. Hence, they get the name smooth muscle
- They make the bulk of the walls of the visceral organs and are also named as visceral muscles

- It is composed of fusiform or spindle shaped cells with a single nucleus at the centre
- The muscle fibres are generally arranged parallel to each other

CARDIAC MUSCLE

- Cardiac muscle is found only in the heart, the immediate proximal ends of aorta, pulmonary artery and pulmonary veins
- It is also known as involuntary and striated muscle. Since the contraction is not under the control of the animal and the muscle fibres also shows the cross striations under microscope as the skeletal muscle fibres, they can be called as *involuntary and striated*
- Unlike the skeletal muscle fibres they are single nucleated,smaller in size and often have multiple branches
- They are attached to the adjacent cells to form a branching network
- The firm end-to-end attachments between cardiac muscle cells are visible under the microscope as dark, transverse lines between the cells.These attachment sites are called*intercalated discs*

MODULE-2: MUSCLES OF THE PECTORAL LIMB - SHOULDER GIRDLE AND SHOULDER REGION



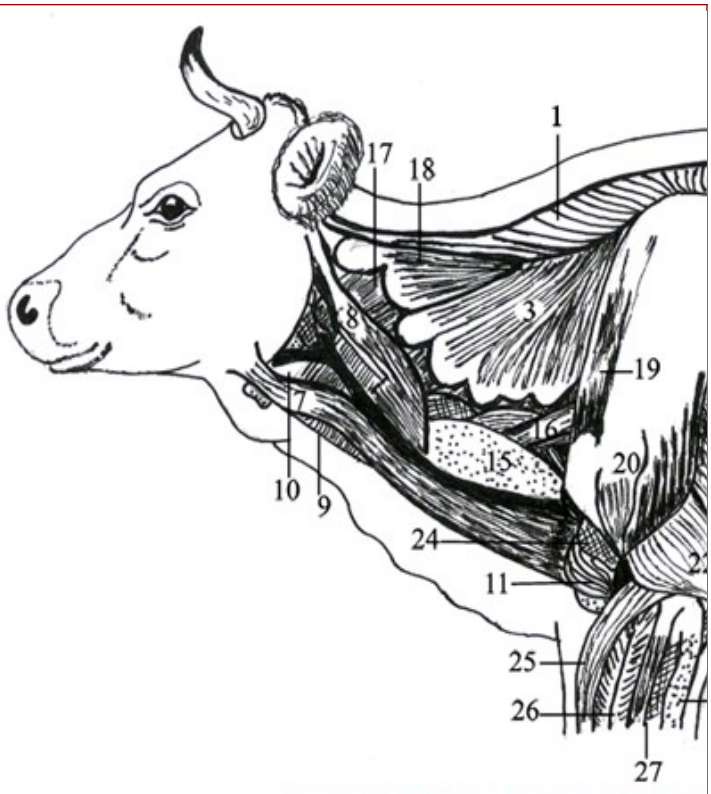
LEARNING OBJECTIVES

- To learn the origin, action and insertion of the muscles in the shoulder girdle.
- To know about its relations to adjacent structures.
- To have a better understanding on its action on joints in that region.
- To learn its blood supply and nervous innervation.
- To understand its action in locomotion.

MUSCLES OF PECTORAL GIRDLE

- The forelimb is attached to the body by a group of muscles called muscles of the shoulder girdle. These muscles connect the forelimb with the head, neck and trunk. They are as follows

- Pectoral muscles
  - Superficial pectoral
    - Cranial superficial pectoral
    - Caudal superficial pectoral
  - Deep pectoral
- Trapezius
  - Trapezius cervicis
  - Trapezius thoracis
- Brachiocephalicus
- Omotransversarius
- Latissmus dorsi
- Serratus ventralis
  - Serrarus cervicis
  - Serratus thoracis
- Rhomboideus
  - Rhomboideus cervicis
  - Rhomboideus thoracis



Deep layer of the pectoral girdle musc

1. Rhomboideus cervicis 2. Rhomboideus thoracis 3
4. Serratus thoracis 5. Latissimus dorsi 6. Lur
7. Sternomandibularis 8. Sternomastoideus 9. Ste
10. Omohyoideus 11. Superficial Pectoral 12. De
13. Obliques abdominis externus 14. External intercostals 15
16. Scalenus dorsalis 17. Obliques capitis posterior 1
19. Supraspinatus 20. Deltoideus 21. Long head
22. Lateral head of triceps 23. Tensor fascia antibrachii 2
25. Extensor carpi radialis 26. Medial digital extensor 2
28. Lateral digital extensor 29. Ulnar head of deep digital flex

MUSCLES OF PECTORAL GIRDLE-PECTORAL MUSCLES

Axilla

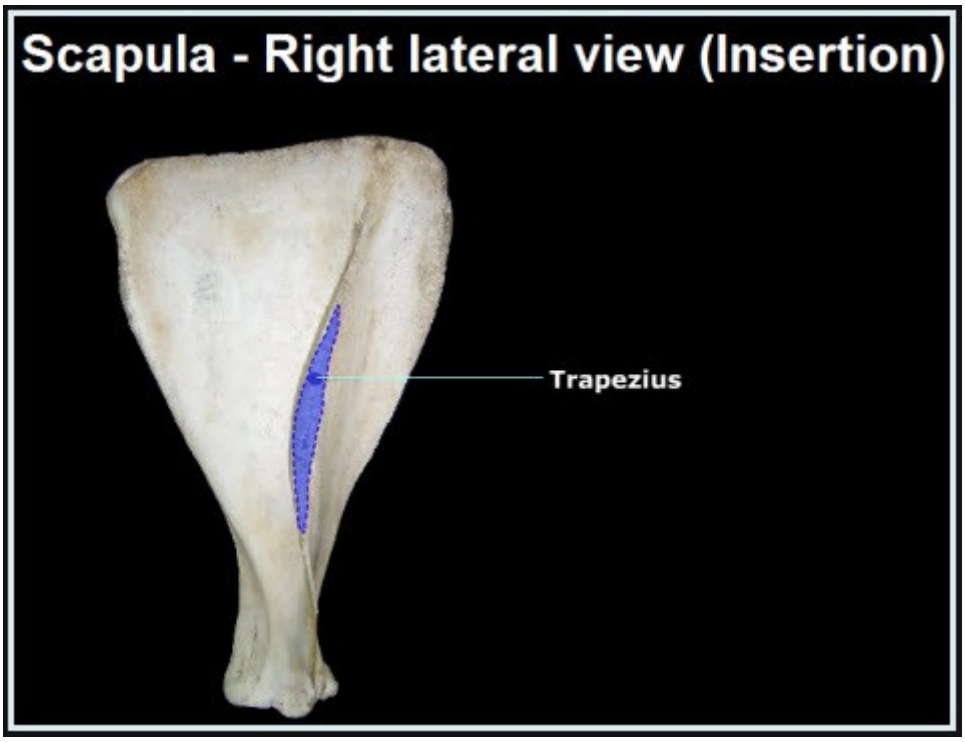
- It is a narrow space between the chest wall and the pectoral limb containing a large amount of loose connective tissue.
- This space is crossed by the large vessels and the nerves intended to supply the muscles of the pectoral limb.
- It corresponds to the armpit of the man.
- In resting condition, this space can scarcely exist, except perhaps to a small extent at its lower part: but it is clearly observed when the limb is abducted.

Pectoral muscles

- These muscles form a thick mass, which occupy the space between the lower part of the chest wall and the medial face of the shoulder and arm. They are divisible into two layers - superficial and deep. The superficial layer is again divisible into anterior and posterior muscles.
- *Superficial Pectoral (Pectoralis superficialis)*
    - Anterior superficial pectoral
        - This is thicker and smaller of the two layers of the superficial pectoral, extending from the manubrium sterni to the antero-ventral part of the arm.
        - Orgin: The ventro-lateral aspects of the anterior part of the sternum.
        - Insertion: In common with the brachiocephalicus, to the anterior edge of the humerus.
        - Action: To adduct the limb and draw it forwards.
    - Posterior superficial pectoral
        - This is closely blended with the preceding muscle and extending from the ventro-lateral aspect of the sternum to the medial side of the forearm.
        - Origin: The ventral and lateral aspects of the anterior part of the sternum behind the origin of the preceding muscle.
        - Insertion: To the crest of the humerus and fascia of the forearm.
        - Action: To adduct the limb and to tense the fascia of the forearm.
- *Deep Pectoral (Pectoralis profundus)*
    - It is a large, fleshy muscle extending from the level of xiphoid cartilage forwards and upwards to the level of the shoulder joint.
    - Origin: The ventral surface of the sternum and tunica abdominalis.
    - Insertion: Medial tuberosity of the humerus.
    - Action: To adduct and retract the limb.
    - Blood supply: External thoracic artery.
    - Nerve supply: Pectoral nerves.

MUSCLES OF PECTORAL GIRDLE - TRAPEZIUS

- It is a broad triangular muscle extending along the dorsal midline from the level of atlas to the end of the thoracic region, and covers a part of the shoulder. It consists of *cervical (trapezius cervicis)* and *dorsal(trapezus thoracis)* parts.
- *Origin:* Ligamentum nuchae and supraspinous ligament from the level of the atlas to the twelfth dorsal vertebra.
- *Insertion:* The tuberous part of the spine of the scapula and the scapular fascia.



- *Action:* To elevate the shoulder as a whole. The cervical part draws it forwards and the dorsal part backwards.
- *Blood supply:* Deep cervical, dorsal and intercostal arteries.
- *Nerve supply:* Spinal accessory nerve.

MUSCLES OF PECTORAL GIRDLE - BRACHIOCEPHALICUS

- This muscle extends from the head, along the neck to the arm. Its upper border is in close apposition with the trapezius and the lower border forms the upper boundary of the jugular furrow. It consists of a dorsal part (cleido-occipitalis) and a ventral part (cleido-*mastoideus),* the division being indicated by the position of exit of cutaneous branches of the ventral divisions of the cervical spinal nerves.
- *Origin: Dorsal part* - occipital bone, ligamentum nuchae. *Ventral part* - mastoid process, wing of atlas and the mandible.
- *Insertion:* The united portion of the two divisions is inserted along with the anterior superficial pectoral to the anterior edge of the humerus.
- *Action:* When the head and neck are fixed, to draw the limb forwards and extend the shoulder joint; when the limb is fixed, the two side muscles together extend the head and neck. Each side muscle acting by itself to incline the head and neck to its own side.
    - *Note:* The deep face of the muscle receives at the lower part of the neck a small bright red fasciculus of muscle, which arises from the cartilage of the first rib. This is the vestige of man.
- *Blood supply:* Inferior cervical, carotid and vertebral arteries.
- *Nerve supply:* Cervical spinal and axillary nerves.

MUSCLES OF PECTORAL GIRDLE - OMOTRANSVERSARIUS

- This muscle extends from the level of the atlas to the shoulder and most part covered by the preceding muscle except at the scapular portion where it is seen as a broad, flat muscular band.
- *Origin:* Wing of atlas and transverse process of the axis.
- *Insertion:* Scapular spine and scapular fascia.

- *Action:* To pull the lower angle of the scapula forwards and upwards and to tense the scapular fascia.
- *Blood supply:* Superior and inferior cervical arteries.
- *Nerve supply:* Cervical spinal nerves.

MUSCLES OF PECTORAL GIRDLE - LATISSIMUS DORSI

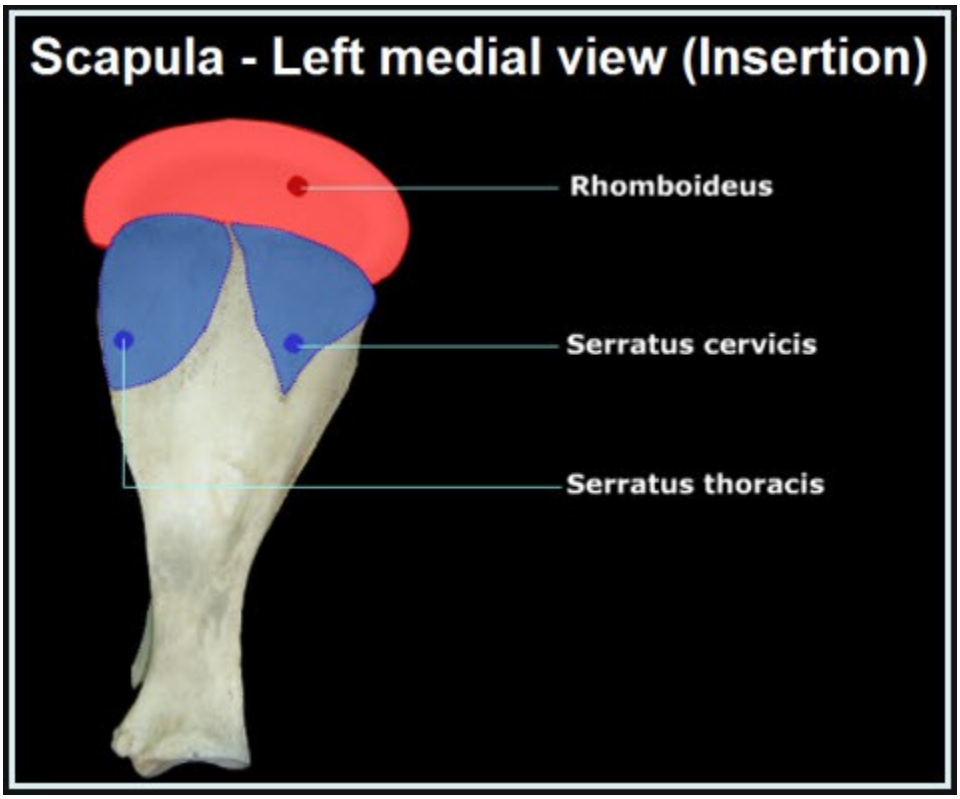
- It is a very wide muscle extending on the lateral wall of the thorax from the dorso-lumbar spine to the arm. It has an aponeurotic origin, which is succeeded by a wide muscular portion.
- Origin: Lumbodorsal fascia, 11 th and 12 th ribs and fascia over the intercostal and external oblique muscles.
- *Insertion:* The anterior part in common with the *teres major* to the medial (teres) tubercle of the humerus; the middle part to the aponeurosis on the deep face of the long head of triceps*;* the posterior part along with the deep pectoral to the medial tuberosity of the humerus. The tensor fasciae antibrachii originates *from* the lateral surface of this muscle.
- *Action:* To flex the shoulder joint
- *Blood supply:* Thoraco-dorsal artery
- *Nerve supply:* Thoraco-dorsal nerve

MUSCLES OF PECTORAL GIRDLE - SERRATUS VENTRALIS

- The serratus ventralis is a large fleshy muscle placed on the lateral side of the neck and thorax and is named as serratus thoracis and serratus cervicis according to the region covered.

Serratus cervicis

- It is a large, thick muscle extends from the level of the second cervical vertebra to the fifth rib. The posterior part of this muscle is overlapped by the two anterior digitations of the succeeding. It lies partly on the neck and partly on the lateral wall of the thorax.
- *Origin:* From the transverse process of the second or third cervical vertebra to seventh cervical vertebra and the lateral face of ribs from first to the fifth rib.
- *Insertion:* The triangular rough area at the dorso-anterior part of the ventral surface of the scapula.



- *Action:* To pull the scapula towards the neck. Two side muscles acting together to extend the neck and singly inclines the neck to its own side.

- *Blood supply:* Superior cervical, dorsal and vertebral arteries.
- *Nerve supply:* Fourth, fifth and sixth cervical spinal nerves and long thoracic nerve.

Serratus thoracis

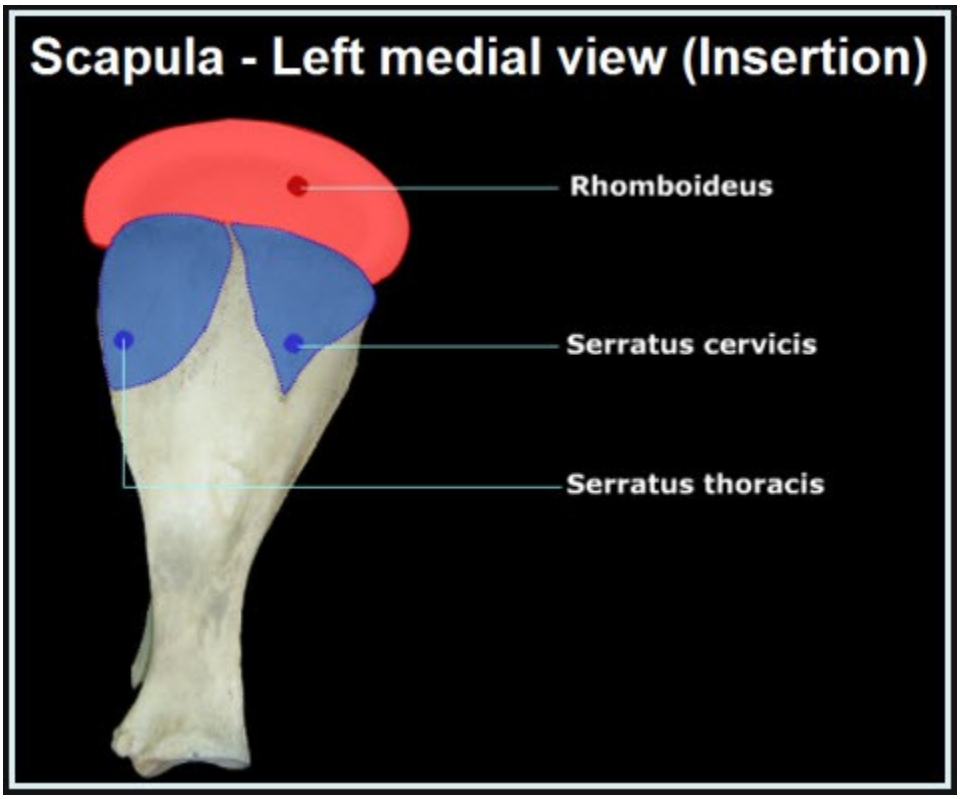
- This muscle is thin and flat muscle covered by a strong glistening aponeurosis. It overlaps the serratus cervicis. Its ventral border is serrated and shows six digitations.
- *Origin:* External surfaces of ribs from 4 th to the 9 th .
- *Insertion:* The rough line at the dorso-posterior part of the ventral surface of the scapula. (See the picture at the top)
- *Action:* The two muscles act together as a sling to suspend the trunk between the two forelimbs. Acting singly it pulls the scapula upwards and backwards. When the limb is fixed, each side muscle acts as an extra-ordinary muscle of inspiration in respiratory exertions.

- *Blood supply:* Intercostal arteries.
- *Nerve supply:* Long thoracic nerve.

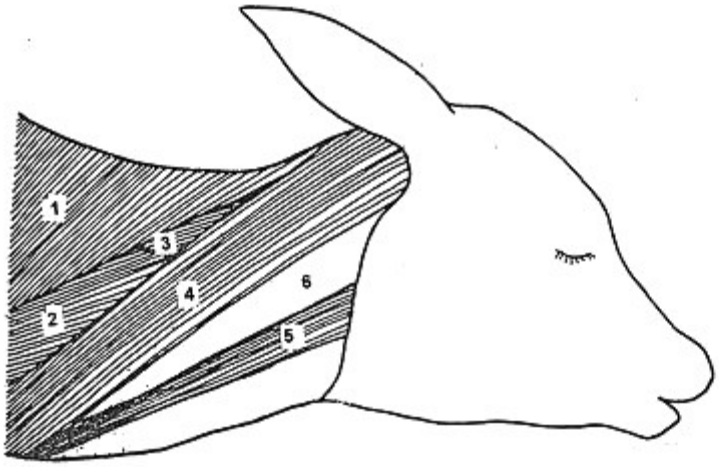
MUSCLES OF PECTORAL GIRDLE - RHOMBOIDEUS

- This muscle extends from ninth to tenth dorsal vertebra to about the level of the middle of the funicular part of the ligamentum nuchae. It is under the cover of trapezius and consists of cervical (rhomboideus cervicis) and dorsal (rhomboideus thoracis) parts
- *Origin:* Ligamentum nuchae, and the spines of dorsal vertebrae from the first to about seventh or eighth

- *Insertion:* The medial surface of the cartilage of the scapula



- *Action:* To draw the shoulder upwards and forwards
- *Blood supply:* Superior cervical and dorsal arteries
- *Nerve supply:* Fifth, sixth, seventh, eighth cervical spinal nerves



Muscles on the lateral aspect of Neck (Superficial dissetion)
1. Trapezius 2. Omotransversarius 3. Spinal accessory nerve (dorsal branch)
4. Brachiocephalicus 5.Sternocephalicus . 6. Jugular furrow

MUSCLES OF SHOULDER

- The muscles of the shoulder are divided into two groups viz.,
    - Medial group
        - Teres major
        - Subscapularis
        - Coraco brachialis
    - Lateral group
        - Deltoideus
        - Supraspinatus
        - Infraspinatus
        - Teres minor

MUSCLES OF SHOULDER - MEDIAL GROUP MUSCLES

Medial group (View image)

- Teres major
- Subscapularis
- Coraco brachialis

Teres Major

- This is a flat, long muscle extends obliquely downwards and forwards between the dorsal angle of the scapula and the arm. It lies behind the subscpularis and on the medial face of the long and medial heads of the triceps
- *Origin:* The dorsal angle of the scapula and the adjacent part of the posterior border of the scapula (view image)
- *Insertion:* By a short flat tendon in common with the latissimus dorsi to the medial tubercle of the humerus
- *Action:* To flex the shoulder and adduct the arm (view image)
- *Blood supply:* Subscapular artery
- *Nerve supply:* Nerve to teres major

Subscapularis

- This muscle occupies the subscapsular fossa and presents three fleshy parts
- Origin: Subscapular fossa(view image)
- *Insertion:* By a flat tendon to the posterior division of the medial tuberosity of the humerus. It is covered by the tendon of origin of coracobrachialis
- *Action:* To adduct the arm (view image)
- *Blood supply:* Subscapular artery
- *Nerve supply:* Nerves to Subscapularis

Coracobrachialis

- The muscle lies partly on the medial face of the shoulder joint and the arm
- Origin: Coracoid process of scapula(view image)
- *Insertion:*
    - To a small area on the upper part of the medial surface of the humerus above the teres tubercle
    - To the middle third of the anterior surface of the humerus
- *Action:* To adduct the arm and flex the shoulder joint
- *Blood supply:* Anterior circumflex artery
- *Nerve supply:* Musculo-cutaneous nerve

MUSCLES OF SHOULDER - MUSCLES ON THE LATERAL ASPECT

Lateral group (View image)

- Deltoideus
- Supraspinatus
- Infraspinatus
- Teres minor

Deltoideus

- This muscle lies at the scapulo-humoral angle, partly on the *triceps* and partly on the *infraspinatus*. It consists of two parts, *acromial* and *scapular*, which are placed one above the other and are separated by an interval
- *Origin:*
  - Acromial part - Acromion process and scapular fascia
  - Scapular part - The posterior border of the scapula
- *Insertion:* To the deltoid tuberosity of the humerus. The scapular part is mostly inserted to the fascia covering the triceps
- *Action:* To flex the shoulder and abduct the arm (view image)
- *Blood supply:* Posterior circumflex artery
- *Nerve supply:* Axillary nerve

Supraspinatus (View flash animation)

- This muscle not only fills up the supraspinous fossa but also extends beyond it and is in contact with the *subscapularis*
- Origin**:** The supraspinous fossa(view image)
- Insertion**:** The muscle divides below the level of the acromion process into two divisions - *medial* and *lateral*. The lateral is inserted to the summit of the tuberosity and medial to the anterior division of the medial tuberosity of the humerus
- Action**:** To extend the shoulder (view image)
- Blood supply: Suprascapular artery
- Nerve supply**:** Suprascapular nerve

Infraspinatus

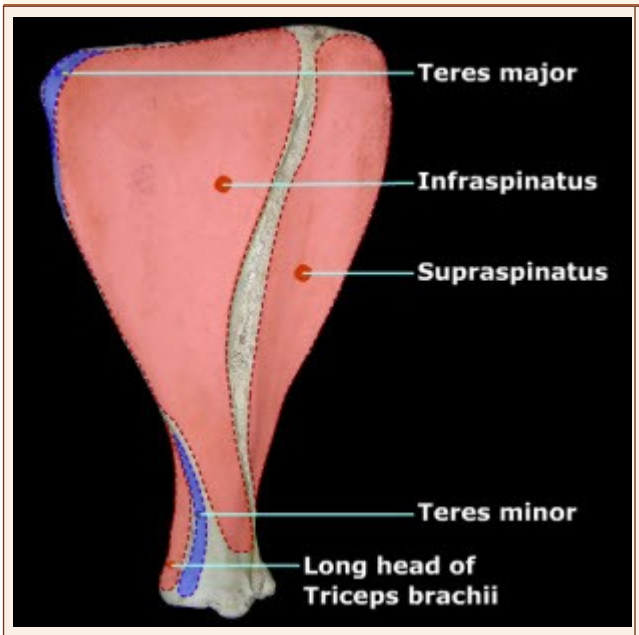
- This muscle covers most of the infraspinous fossa and extends beyond it posteriorly
- Origin**:** Infraspinous fossa (view image)
- Insertion: Two insertions as
- A wide flat tendon to the circular rough area below the summit of the lateral tuberosity of the humerus
- Medial surface of the convexity of the lateral tuberosity of the humerus
- Action**:** To abduct the scapula and rotate it outwards (view image)
- Blood supply**:** Subscapular and suprascapular arteries
- Nerve supply**:** Suprascapular nerve

Teres minor

- This is a small-elongated muscle under the deltoideus, infraspinatus and lies mostly on the triceps brachii

- Origin**:** The rough lines at the distal part of the infraspinous fossa and the posterior border of the scapula(view image)
- Insertion**:** To the deltoid tuberosity and a small rough area above it
- Action**:** To flex the shoulder joint and abduct the arm and rotate it outwards (view image)
- Blood supply**:** Subscapular and suprascapular arteries
- Nerve supply**:** Axillary nerve

MODULE-3: MUSCLES OF THE PECTORAL LIMB - ARM, FOREARM AND MANUS REGION



LEARNING OBJECTIVES

- To learn the origin , action and insertion of the muscles in arm, forearm and manus.
- To know about its relations to adjacent structures.
- To have a better understanding on its action on joints in these regions (arm, forearm and manus).
- To learn its blood supply and nervous ineervation.
- To learn about the tendon attachments of these muscles to the body structures of the limb.
- To understand its action in locomotion-extension, flexion, adduction, abduction etc.
- For choosing site for I/M injections and for nerve blocks in these regions.

MUSCLES OF THE ARM

This group consists of muscles, which are grouped around the humerus. Some arise from the scapula and others from the humerus and all are inserted to the forearm. They are as follows

- Biceps brachii
- Triceps brachii
  - Long head (Caput longum tricipitis)
  - Lateral head (Caput parvum tricipitis)
  - Medial head (Caput medium tricipitis)
- Tensor fascia antibrachii
- Brachialis
- Anconeus

(Note the musculature in arm medial)

Biceps brachii

- It is a long, fusiform muscle situated on the anterior face of the humerus passing obliquely downwards, backwards and inwards. It is thick at its middle and bifid at its insertion
- *Origin:* Tuber scapulae (view image)
- *Insertion:*
  - Radial tuberosity and
  - Ulna
- *Action:* To flex the elbow joint
- *Blood supply:* Anterior circumflex and a direct branch from the brachial artery
- *Nerve supply:* Musculo-cutaneous nerve

Triceps brachii

- This is a large muscle, which fills up the space between the scapula and olecranon process of the ulna. It is made up of three heads
- Long head (Caput longum tricipitis)
  - It is the largest head and is visible on both the lateral and medial faces
  - *Origin*: Posterior border of scapula and the humerus(view image)
  - *Insertion:* The lateral, posterior and medial parts of the summit of the olecranon
  - *Action:* To flex the shoulder and extend the elbow joint(view image)
- Lateral head (Caput parvum tricipitis)
  - It is quadrilateral in shape and lies on the lateral surface of the arm below the long head.
  - *Origin:* The curved line extending from the deltoid tuberosity to the neck of the humerus.
  - *Insertion:* Tendon of long head and lateral aspect of the olecranon.
  - *Action:* To extend the elbow joint.
- Medial head (Caput medium tricipitis)
  - It is the smallest and is situated on the medial surface of the humerus below the insertion of coracobrachialis.
  - *Origin:* The upper third of the medial face of the shaft of the humerus.
  - *Insertion:* Anterior and medial parts of summit of the olecranon process.
  - *Action:* To extend the elbow.
  - *Blood supply:* Posterior circumflex and deep brachial arteries.
  - *Nerve supply:* Radial nerve.

Tensor fascia antibrachii

- This is a long, thin and very narrow muscle extending on the postero-medial face of the long head of triceps.
- *Origin:* Latissimus dorsi.
- *Insertion:* Tendon of long head.
- *Action:* To extend the elbow and tense the fascia of the forearm.
- *Blood supply:* Posterior circumflex and deep brachial arteries.
- *Nerve supply:* Radial nerve.

Brachialis

- This is a curved muscle lodged in the musculo-spiral groove of the humerus.
- *Origin:* Posterior surface of the humerus.
- *Insertion:* Upper part of the medial surface of the radius below the bicipital tuberosity and the ulna.
- *Action:* To flex the elbow joint.
- *Blood supply:* Posterior circumflex and deep brachial arteries.
- *Nerve supply:* Musculo-cutaneous branch of the median nerve.

Anconeus

- This is a small, thick and prismatic muscle covering the brim of the olecranon fossa and covered by all the three heads of the triceps brachii.
- *Origin:* The margins of the olecranon fossa.
- *Insertion:* The anterior and lateral parts of the olecranon.
- *Action:* To extend the elbow joint.
- *Blood supply:* Deep brachial and posterior circumflex arteries.
- *Nerve supply:* Radial nerve.

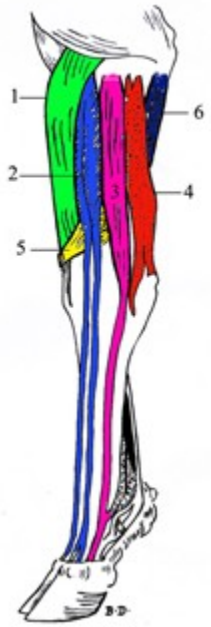
MUSCLES OF THE FOREARM AND MANUS

- Muscles of the forearm and the manus consist of extensors and flexors
- The extensors of the carpus and digit occupy the anterior and lateral aspects of the forearm region while the flexors occupy the posterior or volar aspect
- The medial aspect of the forearm is not occupied by muscles except at its proximal third. Hence, the medial face is mostly subcutaneous
- The extensors are covered by the fasciae, superficial and deep. The superficial fascia is thin and blends with the deep fascia lower down the carpus
- The deep fascia is thin but strong. The fascia is continued down as the fascia of the carpus

EXTENSOR MUSCLE

- These are situated around the dorsal and lateral aspects of the forearm. They are

- Extensor carpi radialis
- Medial digital extensor
- Common digital extensor (Extensor digitalis communis)
- Lateral digital extensor (Extensor digitalis lateralis)
- Extensor carpi obliquus



Extensor muscles of the forearm in Ox
1. Extensor carpi radialis
2. Medial digital extensor
3. Common digital extensor
4. Lateral digital extensor
5. Extensor carpi obliques
6. Ulnar head of deep digital flexor

Extensor carpi radialis

- This is the largest of the extensor muscles and lies over the dorsal face of radius in a nearly vertical direction extending from the lower end of the humerus to the upper end of the large metacarpal bone.

- *Origin:* A sharp ridge on the lateral epicondyle of the humerus and the rough pit outside the coronoid fossa.
    - The fleshy belly of the muscle becomes narrow below and succeeded by a thick tendon which passes down the middle groove on the distal end of the radius through a synovial sheath runs down over the dorsal capsular ligament of the carpus.
- *Insertion:* By a wide flat tendon to the metacarpal tuberosity. Its tendon is crossed over by the tendon of extensor carpi obliquus.
- *Action:* To extend the carpus, and flex the elbow.

Medial digital extensor

- The muscle is slender and situated lateral to the preceding.
- *Origin:* The lateral epicondyle of the humerus and the rough pit outside the coronoid fossa.
    - The muscular belly passes down the forearm by a long narrow tendon about the lower third of the forearm. It then passes through a synovial sheath in common with the tendon of the succeeding muscle in the lateral groove over the dorsal face of the distal extremity of the radius. It passes down the dorso-lateralaspect of the carpus, lying over the dorsal capsular ligament of the carpus and continues its course in the metacarpal region gradually inclining medially. The tendon gradually widens over the first phalanx, receives two *slips* from the suspensory ligament.
- *Insertion:* By two branches to second and third phalanges of the medial digit.
- *Action:* To extend the joints of the medial digit and to abduct the digit.

Common digital extensor (Extensor digitalis communis)

- This is a long, slender muscle situated lateral to the preceding. It has two heads of origin.
- *Origin:* Lateral epicondyle of the humerus and from ulna.
    - The two heads of the muscle fuse about the middle of the forearm and the single belly thus formed. This belly is succeeded by a tendon above the lower third of the forearm and runs in company of the tendon of the preceding muscle in a common synovial sheath in the lateral groove on the dorsal aspects of the distal extremity of the radius. It then runs down the dorsolateral aspect of the carpus over the dorsal capsular ligament of the carpus then down the metacarpus gradually inclining forwards. At the fetlock it divides into two branches.
- *Insertion:* Each branch of the tendon is inserted to the extensor process of the third phalanx.
- *Action:* To extend the joints from the carpus downwards and to approximate the digits.

Lateral digital extensor (Extensor digitalis lateralis)

- The muscle is situated lateral to the preceding.
- *Origin:* Lateral ligament of the elbow: lateral tuberosity of the radius, and the shafts of radius and ulna.
    - The muscle terminates in a tendon, a little above the carpus which passes through a synovial sheath on the lateral aspect of the carpus, passes down the metacarpal region behind the tendon of the preceding muscle, expands as it reaches the first phalanx and receives two slips from the suspensory ligament.
- *Insertion:* The second and third phalanges of the lateral digit.
- *Action:* To extend the joints of the lateral digit and to abduct them.

Extensor carpi obliquus

- The muscle extends from about the middle of the lateral aspect of the forearm in an oblique direction downwards, forwards and inwards to the medial aspect of the upper part of the metacarpal region.
- *Origin:* Lateral and dorsal faces of the radius and ulna.

- The muscle lies under the preceding muscles. The origin is wide and the muscle is succeeded by a flat tendon at the lower third of the forearm, crosses over the tendon of theextensor carpi radialis obliquely inwards, and passes through a synovial sheath in the medial groove on the dorso-medial aspect of the radius.
- *Insertion:* A tubercle on the postero-medial aspect of the upper extremity of the large metacarpal bone.
- *Action:* To extent the carpus and rotate it outwards.
- *Blood supply to all extensors:* Collateral radial artery.
- *Nerve supply:* Radial nerve.

FLEXOR MUSCLES

These muscles are situated around the posterior and medial aspects of the forearm. They are arranged in two layers - superficial and deep.

- Superficial layer
  - Pronator teres
  - Flexor carpi radialis (Medial flexor of the carpus)
  - Flexor carpi ulnaris (Middle flexor of the carpus)
  - Ulnaris lateralis (Flexor metacarpi externus)
- Deep layer
  - Superficial digital flexor (Flexor pedis perforatus)
  - Deep digital flexor (Flexor pedis perforans)

Note the muscle arrangement in the forearm - Volar aspect

FLEXOR MUSCLES - SUPERFICIAL LAYER

Pronator teres

- It is a very small, feeble and vestigeal muscle situated along the medial face of the elbow joint, closely blended with the medial lateral ligament.
- *Origin:* Medial epicondyle of the humerus.
- *Insertion:* Upper part of the medial border of the radius.
- *Action:* Inappreciable as it is vestigeal.
- *Blood supply:* Median artery.
- *Nerve supply:* Median nerve.

Flexor carpi radialis (Medial flexor of the carpus)

- This is a narrow muscle placed immediately behind the preceding.
- *Origin:* Medial epicondyle of the humerus. The tendon is provided with a synovial sheath above the carpus.
- *Insertion:* A tubercle on the postero-medial part of the upper extremity of the large metacarpal bone.
- *Action:* To flex the carpus and extend the elbow.
- *Blood supply:* Median artery.
- *Nerve supply:* Median nerve

Flexor carpi ulnaris (Middle flexor of the carpus)

- This is a wide muscle situated behind the preceding and covers the medial surface of the forearm.
- *Origin:* Has two heads of origin - humeral head from the medial epicondyle of the humerus and ulnar head from the medial face of the olecranon.
- *Insertion:* The supero-medial half of the accessory carpal bone.

- *Action:* To flex the carpus and extend the elbow.
- *Blood supply:* Median artery.
- *Nerve supply:* Ulnar nerve.

Ulnaris lateralis (Flexor metacarpi externus)

- It is a large, thick muscle situated behind the lateral digital extensor.
- *Origin:* Lateral epicondyle of the humerus.
- *Insertion:* By a short thick tendon to the supero-lateral half to the carpal bone and by a narrow long tendon to the lateral aspect of the upper extremity of the large metacarpal.
- *Action:* To flex the carpus and extend the elbow.
- *Blood supply:* Collateral radial artery.
- *Nerve supply:* Radial nerve.

FLEXOR MUSCLES - DEEP LAYER

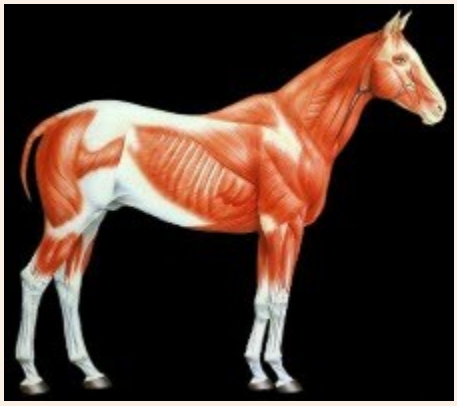
Superficial digital flexor (Flexor pedis perforatus)

- This muscle is under cover of flexor carpi ulnaris.
- *Origin:* Medial epicondyle of humerus.
- Its muscular belly divides into two parts at the lower third of the forearm. Each end terminates in a tendon and the superficial one passes over the carpal canal. It is provided with a synovial sheath below the level of the accessory carpal. The deep part passes through the carpal canal in company with the deep flexor and is connected to it by a strong fibrous band. The common tendon divides above the fetlock into branches each of which forms along with a *branch* of the posterior division of the suspensory ligament, a ringfor the passage of the tendon of the deep flexor of the digit. The tendon of the deep part has a synovial sheath in the carpal canal. The ring, through which the deep flexor passes, is provided with a synovial sheath.
- *Insertion:* The volar face of the upper extremity of the second phalanges.
- *Action:* To flex the digits and carpus and extend the elbow.
- *Blood supply:* Median artery.
- *Nerve supply:* Ulnar and median nerves.

Deep digital flexor (Flexor pedis perforans)

- This is the largest of the flexor muscles and is partly under the cover of the preceding.
- *Origin:* It has three heads of origin - humeral, radial and ulnar.
    - The humeral heads are two, and arise from the medial epicondyle of the humerus.
    - The radial head is the deepest and smallest and arises from the lateral part of the volar face of the radius at its upper half.
    - The ulnar head is the most superficial and is situated between the flexor carpi ulnaris and ulnaris lateralis. It arises from both the faces of the olecranon.
    - Each head is succeeded by a tendon, which unite and form a common tendon just above the carpus. The common tendon passes through the carpal canal and in metacarpal region it passes between the suspensory ligament in front and the superficial digital flexor tendon behind. It divides above the fetlock into two divisions, which pass through the rings of the superficial flexor. The tendon of the muscle is provided with synovial sheaths in the carpal canal and the rings formed by the superficial flexor in the fetlock.
- *Insertion:* The volar surfaces of the third phalanges of the two digits.
- *Action:* To flex carpus and digits and extend elbow.
- *Blood supply:* Median artery and common interosseous artery.
- *Nerve supply:* Median and ulnar nerves.
- The lumbricales of the horse are absent, unless we regard as such the muscle bundles which arise on the deep flexor and are inserted into the superficial flexor tendon at the carpus.
- The interossei musculi is only one - interosseous medius or suspensory ligament is present.

MODULE-4: MUSCLES OF THE PECTORAL LIMB - HORSE AND DOG



LEARNING OBJECTIVES

- To study the muscles of shoulder, arm, forearm and manus in horse and dog.
- To compare the difference in the muscles of pectoral limb of horse and dog with that of cattle.
- To learn the specific action of the muscles in comparison to that of Ox.
- For choosing site for I/M injections and for nerve blocks in these regions.

MUSCLES OF THE THORAIC LIMB-HORSE

- The variations in the musculature of the horse is given below.
  - The anterior superficial pectoral is more distinct than the posterior.
  - The deep pectoral is divisible into anterior and posterior divisions. The anterior deep pectoral extends in front of the supraspinatus to the cervical angle of the scapula. The posterior is fan shaped.
  - The trapezius is distinctly separable into cervical and dorsal parts by an intermediate aponeurosis.
  - The omotransversarius is absent.
  - The brachiocephalicus is less distinct in its division into two parts.
  - The serratus thoracis and serratus cervicis together form a wide fan-shaped muscle serratus ventralis, which is inserted to the two triangular areas on the medial surface of the scapula.
  - The subscapsularis does not present three divisions. It has only one fleshy part.
  - The capsularis is a very fine narrow muscle arising just above the posterior part of the rim of the glenoid cavity and is inserted to the posterior part of the neck of the humerus by insinuating itself between the fibres of origin of the brachialis. This muscle raises the capsule of the shoulder joint during flexion of the joint.
  - The part of the deltoideus corresponding to the acromial part of the ox arises from the spine of the scapula by means of strong aponeurosis covering the infraspinatus.
  - The tendon of origin of the biceps brachii is adapted to the biciptial groove.
  - The tensor fascia antibrachii is very wide below. It is inserted to
    - Deep fascia of the forearm
    - The olecranon.
  - The extensor carpi radialis resembles that of the ox.
  - The medial digital extensor is absent.
  - The extensor pedis or common digital extensor arises in common with the preceding. Its tendon descends in a synovial sheath over the carpus, passes down the metacarpus and at the fetlock. It receives two slips from the suspensory ligament to form the broad ligament, which is inserted to the extensor process of the pedis.
  - The lateral digital extensor is smaller. It arises from the humerus and the radius and its tendon is inserted to the prominence on the dorsal aspect of the upper extremity of the first phalanx.
  - The extensor carpi obliquus is inserted to the head of the medial small metacarpus bone.
  - The pronator teres is usually not present or is represented by a tendinous band.
  - The flexors of the metacarpus resemble that of the ox.

- The superficial digital flexor does not divide into two parts. Its tendon is reinforced above the carpus by a strong fibrous band - the *superior check ligament*. The ring for the deep flexor is formed entirely by the superficial flexor tendon.
- The deep digital flexor presents the same heads. Its tendon receives about half way down the metacarpus the *inferior check ligament*. It is inserted to the semilunar crest and tendinous surface of the os pedis.

Lumbricales (medialis and lateralis)

- These are two slender bundles arises from the deep flexors tendon and in the fibrous tissue of ergot. They lie on either side of the flexor tendons.

Interossei

- These are three in number and lie in the metacarpal groove.
- Two of these i.e the medialis and lateralis, are very slender, and each arises from the corresponding small metacarpal bone, near its proximal extremity.
- The tendons of these are lost in the fascia at the fetlock.
- The third is the interosseous medius or suspensory ligament.

MUSCLES OF THE THORACIC LIMB-DOG

- The variations in the musculature of the dog is given below.
  - The *posterior superficial pectoral* is thin and narrow.
  - The *anterior deep pectoral* is feeble and terminates along with the posterior deep pectoral on the humerus.
  - The *trapezius* is thin and divided into cervical and dorsal portions.The right and left muscles meet on a fibrous raphe.
  - The *omotransversarius* is a well developed muscle arising from the spine of the scapula and maintains uniform thickness.
  - The *brachiocephalicus* is distinct in its division into two parts.
  - The *serratus ventralis* is highly developed muscle bearing no marks on the separation between *serratus thoracis* and *serratus cervicis*. It is a semicircular suspension starting from the third tro seventh cervical vertebra and first eight ribs and inserted to the cervical and thoracic angles of the scapula.It covers the most of the chest region.
  - The *rhomboideus is very extensive.*
  - The *teres major* is thicker.
  - The *subscapsularis gives a glistening appearence.*
  - The capsularis is absent.
  - The *deltoideus* is well developed and coracobrachialis is very small.
  - The *biceps brachii* is very prominent.
  - The *triceps* heads are marked by deposition of fat.There is an additional accessory head which arises from below the head of the humerus.
  - The *brachioradialis* is a consonant muscle of the forearm extending from the lateral epicondyle of the humerus and ending on the medial border of the radius.
  - The *common digital extensor* arises from the lateral epicondyle of the humerus as a single muscle and terminates by four tendons attaches to the third phalanges of the second to fifth digits.
  - The extensor of the first and second digits is a small muscle placed between the common digital and the lateral digital extensor.Arising from the shaft of the ulna,it terminates by joining the tendon of the common digital extensor and giving slips to the first and second digits.
  - The *lateral digital extensor* a is a muscle with double belly which is not common. It attaches to the third pahalanges of the third and the fourth digit and is called extensor of the third and

fourth digits. The second one attaches to the third phalnx of the fifth digit.Both the tendons reach the third phalnx by joining with the tendon of the common digital extensor.

- The *extensor carpi obliquus* is inserted to first metacarpal bone, abducting the first digit and manus.
- The *pronator teres* helps in pronation.
- The *flexor carpi radialis* tendon divides and terminates on the second and third metacarpal bones.
- The *flexor carpi ulnaris* has two heads of originas humoral and ulanr which terminate on the accessory carpal.
- The s*uperficial digital flexor* has single origin from the medial condyle of the humerus.Its muscular belly extends to the back of the carpus. Here,it is reinforced by slipd from the accessory carpal and the proximal sesamoid.The four bands into which it divides terminate on the second phalnes of the second to fifth digits.
- The *deep digital flexor* presents the same heads. It has two attachments one of which terminates on the first digit and the other divides into four branches which are attached to the third phalanges of the second to fifth digits.In its course it passes through the tendon of the superficial digital flexor.
- *Palmaris longus* joins thew deep digital flexor to the superficial flexor,originating from the middle of the radius and terminating behind the carpal.

MODULE-5: MUSCLES OF THE PELVIC LIMB - HIP AND THIGH

LEARNING OBJECTIVES

- To study the origin, insertion and action of the muscles of hip and thigh region both medially, laterally and anteriorly.
- To have a better understanding on the muscular boundaries of pelvic cavity to help in easy maneuvering or handling of pelvic viscera during rectal, vaginal examination and treatment of dystocia, prolapsed and torsion in cattle.
- For choosing site for I/M injections and for nerve blocks and operative procedures in hip and thigh.
- To understand the arterial and venous course in this region for recording pulse and intravenous infusion.

FASCIA OF THE THIGH

- The superficial fascia of the thigh does not merit any special description
- The internal portion of the deep fascia covers the first layer of the muscles on the inner aspect of the thigh and becomes continuous inferiorly with the fascia of the leg and interiorly with that part of the deep fascia, which covers the anterior and lateral parts of the thigh
- The portion of the deep fascia covering the lateral and anterior surfaces of thigh is called as tensor fascia latae; it is continuous with the gluteal fascia above
- The tensor fascia latae and one of the terminations of the biceps femoris are inserted into the fascia latae, which is attached to the patella and its medial and lateral ligaments
- It becomes continuous with the fascia covering the muscles on the medial aspect of the thigh

LATERAL MUSCLES OF THE HIP AND THIGH

The lateral aspect of the hip and thigh muscles are as follows (Look at the hip and thigh for its musculature)

- Tensor fasciae latae (Tensor vaginae femoris)
- Biceps femoris
- Gluteus medius (Middle gluteus)
- Gluteus profundus (Deep gluteus)
- Semitendinosus

Tensor fasciae latae (Tensor vaginae femoris)

- This is the anterior most muscle on the external aspect of the hip and thigh. It is triangular in form with its base below and apex at the lateral angle of the ilium.
- *Origin:* Lateral angle of ilium.
- *Insertion:* Fascia latae and lateral patellar ligament
- *Action:* To tense the fascia latae, flex the hip and extend the stifle.
- *Blood supply:* Circumflex iliac artery.
- *Nerve supply:* Anterior gluteal nerve.
- *(Note:* The superficial gluteus muscle is absent in ox. The anterior part of this muscle appears to fuse with the tensor fascia latae and the posterior part with the biceps femoris.)

TOP

Biceps femoris

- This is a large quadrilateral muscle lying behind the middle gluteus and tensor fascia latae. It extends from the sacral spines to the proximal extremity of the leg**.** It is wide at its proximal part as it has the posterior portion of the superficial gluteus blended with it.
- *Origin:* Sacral spines, sacro-sciatic ligament, tuber ischii and gluteal fascia.
- *Insertion:* The lower part of the muscle is succeeded by three aponeurotic tendons, which are inserted to the patella, tibial crest and fascia latae.
- *Action:* To extend the limb and abduct it to assist in kicking and propulsion. The anterior part extends the stifle joint; the middle part extends the hip and the posterior part tenses the fascia latae.
- *Blood supply:* Posterior gluteal, deep femoral and posterior femoral arteries.
- *Nerve supply:* Posterior gluteal and sciatic nerves.

TOP

Gluteus medius (Middle gluteus)

- This muscle is the larger of the two gluteal muscles. It covers the greater part of the gluteal surface of the ilium and the lateral wall of the pelvis, and extends on the lumbar part of the longissimus dorsi as far forwards as the fourth lumbar vertebra. It is partly covered by the combined biceps femoris and superficial gluteus muscle. The muscle extends outwards and forwards beyond the level of the anterior edge of the ilium.
- *Origin:* Lateral angle of the ilium, sacro-sciatic ligament, gluteal surface of the ilium and gluteal fascia.
- *Insertion:* Three branches of insertion – *anterior, middle and posterior*. Of these, the posterior is muscular and the other two are tendinous. (1) *Anterior* - by a short tendon to the area below the trochanter major; (2) *Middle* - by a strong tendon to the summit of the trochanter major (3) P*osterior*- by a fleshy insertion to the trochanteric ridge.
    - The part inserted to the area below the trochanter major is easily separable and deep and is called the gluteus accessorius**.**

- *Action:* To extend the hip joint and abduct the limb to assist in kicking and propulsion.
- *Blood supply:* Anterior gluteal artery.
- *Nerve supply:* Anterior gluteal nerve.

TOP

Gluteus profundus (Deep gluteus)

- This muscle is completely under the cover of the preceding. It is thinner and smaller of the two gluteal muscles and irregularly quadrilateral in shape. It extends from the lateral angle of the ilium over the hip joint below the trochanter major of the femur.
- *Origin:* Lateral angle of the ilium and the gluteal surface in front of the gluteal line; the lateral surface of the ischiatic spine.
- *Insertion:* A tubercle, a little below the base of the trochanter major below the insertion of middle gluteus.
- *Action:* To abduct the limb and rotate it inwards.
- *Blood supply:* Anterior gluteal artery.
- *Nerve supply:* Anterior gluteal nerve.

TOP

Semitendinosus

- It is a very long muscle extending from the tuber ischii to the proximal third of the medial face of the tibia. It lies at first between the biceps femoris and semimembranosus; in its lower third it lies between the biceps femoris and gracilis.
- *Origin:* Ventral surface of the tuber ischii.
- *Insertion:* Tibial crest and fascia latae.
- *Action:* To extend the hip and assist in kicking and propulsion.
- *Blood supply:* Deep femoral artery.
- *Nerve supply:* Sciatic nerve.

MEDIAL MUSCLES OF THE THIGH (CRURAL REGION)

- This region has eight muscles arranged in superimposed layers. They are
  - First layer
    - Sartorius
    - Gracilis
  - Second layer
    - Pectineus,
    - Adductor and
    - Semimembranosus
  - Third layer
    - Quadratus femoris,
    - Obturator internus,
    - Obturator externus and
    - Gemellus
- Of these the obturator internus is placed within the pelvic cavity.

FIRST LAYER

Sartorius

- This is a long, thin and flat muscle and is the anterior of the two muscles in the first layer. It is narrow at its distal extremity. Its proximal extremity is situated in the abdominal cavity at the pelvic brim and the remainder of its muscular belly is on the medial aspect of the thigh. It extends in an oblique direction downwards and backwards from the posterior part of the sub lumbar region to the medial aspect of the thigh.
- *Origin:* By two heads. (1) From iliac fascia and (2) From the tendon of psoas minor. The femoral vessels pass between the parts.
- *Insertion:* Medial straight ligament of patella and the fascia latae and the tuberosity of tibia.
- *Action:* To flex the hind limb and adduct the limb.
- *Blood supply:* Femoral artery.
- *Nerve supply:* Saphenous nerve.

Gracilis

- This muscle is extensively united to its fellow at the origin and is the larger and wider of the two muscles of this layer.
- *Origin:* Pelvic symphysis and prepubic tendon.
- *Insertion:* Medial patellar ligament, medial surface of the tibia and fascia latae.
- *Action:* To abduct the limb and tense the fascia of the leg.
- *Blood supply:* Deep femoral artery.
- *Nerve supply:* Obturator nerve.
- *(Note:* At the proximal part of the medial face of the thigh, the gracilis and the sartorius are separated by a triangular space, the femoral triangle, which lodges the femoral vessels)

TOP

SECOND LAYER

Pectineus

- It is a large, thick, conical muscle situated under the sartorius and gracilis. It extends in an oblique direction downwards, slightly forwards and outwards from the anterior border of the pubis to the proximal extremity of the tibia.
- *Origin:* Ventral surface of the pubis and the prepubic tendon.
- *Insertion:* The middle of the medial border of the posterior surface of the femur and in common with sartorius and gracilis to the medial tuberosity of the tibia.
- *Action:* To abduct the limb, flex the hip and rotate the femur inwards.
- *Blood supply:* Deep femoral artery.
- *Nerve Supply:* Obturator nerve.

Femoral canal

  - It is a muscular canal bounded in front by the *sartorius,* behind by the *pectineus,* medially by the *gracilis* and *iliopsoas* and *vastus medialis* laterally.
  - Its lower opening is at the insertion of the fibres of the pectineus. The upper opening of this canal is the *femoral ring*, which opens into the abdomen.
  - It is bounded in front by the *Poupart's ligament or inguinal ligament,* behind by the anterior border of the pubis and laterally by the tendon of *psoas* minor.
  - It lodges the *femoral vessels, saphenous artery, vein and nerve.* The canal terminates below at the lower part of the insertion of the *pectineus.*

Adductor

- This muscle lies behind the vastus internus and pectineus. It extends from the ventral surface of the pubis and ischium, in an oblique direction, downwards, forwards and outwards to the distal part of the posterior surface of the femur.
- *Origin:* Ventral surface of the pubis and ischium.
- *Insertion:* The lateral part of the posterior surface of the femur.
- *Action:* To adduct the limb, extend the hip and rotate the femur inwards.
- *Blood supply:* Deep femoral artery.
- *Nerve supply:* Obturator nerve.

Semimembranosus

- This is very large quadrilateral muscle lies behind the adductor and a large extent of medial face of this muscle comes to view on removal of the muscles of the first layer. It forms the posterior most muscle of the second layer.
- *Origin:* Ventral face of the ischium and the tuber ischii.
- *Insertion:* Medial epicondyle of the femur and the medial condyle of the tibia.
- *Action:* To extend the hip and adduct the limb.
- *Blood supply:* Deep femoral artery.
- *Nerve supply:* Sciatic nerve.

TOP

THIRD LAYER

Note: The following muscles are more on the posterior aspect of hip joint.

Quadratus femoris

- It is a narrow short muscle lying under the cover of the origin of the *adductor* and *semimembranosus*. .
- *Origin:* Ventral face of the ischium.
- *Insertion:* Trochanter minor of the femur.
- *Action:* To extend the hip and adduct the thigh.
- *Blood supply:* Deep femoral artery.
- *Nerve supply:* Sciatic nerve.

Obturator externus

- This muscle is made up of coarse muscular bundles situated around the obturator foramen on the ventral surface of the ischium.
- *Origin:* Ventral surface of ischium and pubis around the obturator foramen.
- *Insertion:* In common with the obturator internus to the trochanteric fossa.
- *Action:* To adduct the thigh and rotate it outwards.
- *Blood supply:* Deep femoral artery.
- *Nerve supply:* Obturator nerve.

Obturator internus

- This muscle is extensive and is situated on the floor of the pelvic cavity above and mostly behind the obturator foramen.
- *Origin:* Pelvic surface of the ischium and pubis around the obturator foramen.

- *Insertion:* The tendon passes through the obturator foramen and is inserted in common with preceding muscle to the trochanteric fossa.
- *Action:* To rotate the femur outwards.
- *Blood supply*: Deep femoral artery.
- *Nerve supply:* Obturator nerve.

Gemellus

- This is a small, thin muscle extending from the ventral surface of the ischium to the trochanteric fossa.
- *Origin:* Lateral border of the ischium at the lesser sacro-sciatic foramen and from the lateral face of the posterior part of the sacro-sciatic ligament.
- *Insertion:* Trochanteric fossa.
- *Action:* To rotate the femur outwards.
- *Blood supply:* Deep femoral artery.
- *Nerve supply:* Sciatic nerve.

ANTERIOR MUSCLES OF THE THIGH

The following are the muscles present on the anterior aspect of the thigh.

- Sartorius (Already described in medial group of muscles of thigh)
- Quadriceps femoris
  - Rectus femoris
  - Vastus lateralis
  - Vastus medialis
- Articularis genu

Quadriceps femoris

- This is a massive muscle composed of four divisions situated around the anterior, lateral and medial faces of the femur. Of these four divisions, the first three are not very distinct from each other for most of their extent. The rectus femoris arises from the ilium, while the other three arise from the femur; all terminate on the patella.
- Rectus femoris
  - This is a round muscle embedded between the vastus medialis and lateralis. It extends from the cotyloid angle of the ilium to the patella.
  - *Origin:* By two heads from the two depressions at the lowermost part of the cotyloid border of the ilium, above and in front of the acetabulum.
  - *Insertion:* The base and anterior surface of the patella.
  - *Action:* To extend the stifle and to flex the hip.
- Vastus lateralis
  - This muscle is thicker and larger than the vastus medialis and lies on the lateral surface of the femur.
  - *Origin:* lateral border and surface of the femur from the great trochanter to the supracondyloid fossa.
  - *Insertion:* The lateral part of the anterior surface of the patella, and tendon of rectus femoris.
  - *Action:* To extend the stifle.
- Vastus medialis
  - This muscle is thinner and narrower than the preceding one and lies on the medial face of the femur.
  - *Origin:* The medial and a narrow part of the anterior part of the femur.
  - *Insertion:* The medial patellar ligament and tendon of rectus femoris.
  - *Action:* To extend the stifle joint.

- Vastus intermedius
    - This muscle consists of two parts situated deeply on the anterior face of the femur covered by the three preceding divisions.
    - *Origin:* Anterior surface of the femur.
    - *Insertion:* Base of the patella and femoro-patellar capsule.
    - *Action:* To extend the stifle and raise the capsule during extension of the joint.
    - *Blood supply:* Anterior femoral artery.
    - *Nerve supply:* Femoral nerve.

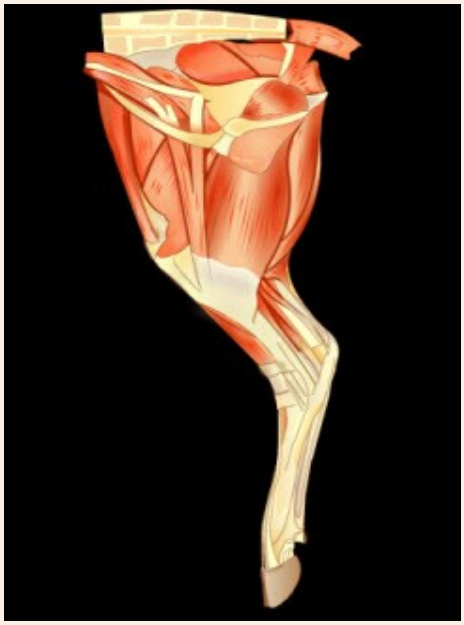
Note: The three straight ligaments of the patella are in face of the tendons of insertion of the quadriceps muscle; the patella being developed as a sesamoid bone in the tendons .

TOP

Articularis genu

- This is a very small muscle situated at the lower third of the anterior surface of the femur under the cover of the v*astus Intermedius*.
- *Origin:* Lower part of anterior face of the femur.
- *Insertion:* Femoro-patellar capsule.
- *Action:* To raise the capsule.
- *Blood supply:* Anterior femoral artery.
- *Nerve supply:* Femoral nerve.

MODULE-6: MUSCLES OF THE PELVIC LIMB - LEG AND FOOT



LEARNING OBJECTIVES

- To learn the origin, insertion and action of the muscles present in the anterior and posterior part of leg, dorsal and plantar aspect of metatarsus and digits.
- To learn its relation with adjacent structures.
- To understand the tarsal canal and action of extensors and flexors in the joints of leg and foot.
- To understand its major role in locomotion.
- To learn its vascular supply and nervous innervations.

MUSCLES OF THE LEG AND FOOT

Fascia

- The fascia of the leg consists of several super-imposed layers.
- The superficial fascia is continuous with that of the thigh.

- The tendons of the tensor fascia latae, biceps femoris, semitendinosus, gracilis and sartorius form the next layer. These two layers frequently use together and are attached to the patellar ligaments, tibial crest and medial face of the tibia.
- These layers unite behind the deep digital flexor at about the middle of this region.
- The third layer of fascia furnishes sheaths for the muscles.
- The tarsal fascia of the leg is continued down over the metatarsals and is blended with its ligaments and is attached to the eminences on the bones. It is thick in front and behind and thins laterally.
- The metatarsal and digital fascia is almost similar to those of the forelimb.
- The muscles of the leg are classified under two groups as
    - Dorsolateral group
        - Complex muscle
            - Peroneus tertius
            - Long digital extensor (extensor digital longus)
            - Medial digital extensor
        - Tibialis anterior (Tibialis anticus)
        - Peroneus longus
        - Lateral digital extensor (Extensor digitalis lateralis)
        - Extensor digitalis brevis (Short extensor)

- Plantar group
    - Superficial layer
        - Gastrocnemius
        - Soleus
        - Superficial digital flexor
    - Deep layer
        - Popliteus
        - Deep digital flexor

- These muscles almost completely envelop the tibia leaving only the medial face uncovered.

DORSOLATERAL GROUP

Complex muscle

- This is a single muscle situated on the dorso-lateral aspect of the leg**.**
- *Origin:* By a strong tendon from the extensor fossa of the femur.
- This shows about its middle three muscular bellies, each of which is succeeded by a tendon.
    - The peroneus tertius is the most superficial part and well developed. It is located in front and partly internal to the other two bellies. It is succeeded by a strong flat tendon, which is perforated by the tibialis anterior. It is inserted to the tubercle at the dorso-medial aspect of the proximal extremity of the large metatarsal bone. It is provided with a synovial sheath at the tarsus.
    - The long digital extensor (extensor digital longus) is lateral to the preceding. It is succeeded by a tendon, which behaves like the tendon of common digital extensor of the forelimb. The tendon is inserted into the extensor process of the third phalanx.
    - The third division is the medial digital extensor and is under cover of the preceding two divisions. Is succeeded by a tendon, which resembles that of the forelimb in its course and terminations. The long and medial digital extensor has a common synovial sheath at the tarsus.
- *Action:* To flex the hock and extend the digits.
- *Blood supply:* Anterior tibial artery.
- *Nerve supply:* Deep peroneal nerve.

Tibialis anterior (Tibialis anticus)

- This is a thin, triangular muscle lies under the cover of the complex muscle on the lateral surface of the tibia and arises by two heads.
- *Origin:*
    - Tuberosity of the tibial crest;
    - Upper part of the lateral border of the tibia and the fibrous cord of the fibula. Its tendon passes through the tendon of the peroneus tertius. Its tendon is provided with a synovial sheath at the tarsus.
- *Insertion:* The postero-medial surface of the upper extremity of the large metatarsal and the second and third tarsal bones.
- *Action:* To flex the hock.
- *Blood supply:* Anterior tibial artery.
- *Nerve supply:* Deep peroneal nerve.

Peroneus longus

- The muscle is situated between the peroneus tertius and lateral digital extensor.
- *Origin:* Lateral condyle of the tibia and the fibrous cord of the fibula.
    - The tendon crosses over the tendon of lateral digital extensor, passes under the lateral ligament passes through a bony groove formed between the tarsal bones and the large metatarsal. It is provided with a synovial sheath at the tarsus.
- *Insertion:* To the first tarsal and proximal end of the large metatarsal bone.
- *Action:* To rotate the hock inwards.
- *Blood supply:* Anterior tibial artery.
- *Nerve supply:* Deep peroneal nerve

Lateral digital extensor (Extensor digitalis lateralis)

- This is situated lateral to the preceding.
- *Origin:* Lateral ligaments of the stifle and the lateral condyle of the tibia.
    - The muscle is succeeded by a tendon, which passes through a synovial sheath in common with that of the preceding muscle, crosses under that tendon and thereafter, it resembles the tendon of the muscle of the forelimb in its course and termination. It is provided with a synovial sheath at the tarsus.
- *Blood supply:* Anterior tibial artery.
- *Nerve supply:* Superficial peroneal nerve.

Extensor digitalis brevis (Short extensor)

- This is a narrow muscle situated on the dorsal surface of the metatarsus.
- *Origin:* A depression on the dorsal surface of the metatarsus.
- *Insertion:* Tendon of long digital extensor.
- *Action:* To assist the long digital extensor.
- *Blood supply:* Anterior metatarsal artery.
- *Nerve supply:* Deep peroneal nerve.

PLANTAR GROUP

Complex muscle

This includes the muscles arranged in two superimposed layers behind the tibia. The superficial layer consists of gastrocnemius, soleus, superficial digital flexor and the deep layer is made up of popliteus and deep digital flexor.

SUPERFICIAL LAYER

Gastrocnemius

- This is placed behind the femoro-tibial articulation and extends from the distal third of the femur to the proximal extremity of the tuber calcis. This large muscle has two heads of origin.
- *Origin:* *Medial head*-the medial supracondyloid crest and the *lateral head*- outer lip of the supracondyloid fossa.
    - Each head is succeeded by tendon, which unite above the middle of the leg and the common tendon is placed immediately behind the tendon of the superficial flexor. By a twist in the tendons at a lower third of the leg, the tendon of the superficial flexor lies behind the tendons of the gastrocnemius. The tendon of the superficial digital flexor and the fibrous bands attaching it to the sides of the os calcis, completely cover the tendon of the gastrocnemius. These two tendons at the distal part of the leg are together spoken of as *tendo calcaneous* or *hamstring* or *tendo Achilles*.
- *Insertion:* Summit of the tuber calcis.
- *Action:* To extend the hock.
- *Blood supply:* Popliteal and posterior femoral artery.
- *Nerve supply:* Tibial nerve.

Soleus

- This is very thin, long muscle situated immediately under the deep fascia and between it and the deep digital flexor. It passes downwards along the lateral border of the external head of the gastrocnemius.
- *Origin:* Lateral condyle of the tibia and proximal extremity of fibula.
- *Insertion:* Lateral head of the gastrocnemius above its middle.
- *Action:* To assist the gastrocnemius in the extension of the hock.
- *Blood supply:* Popliteal artery.
- *Nerve supply:* Tibial nerve.

Superficial digital flexor

- This muscle is very closely blended between the two heads of the *gastrocnemius*.
- *Origin:* The supracondyloid fossa.
    - The muscle is succeeded by a tendon, which is in front of the tendon of the gastrocnemius at the middle of the leg, but below, by a twist in these tendons it comes to lie behind it. It passes over the summit of the tuber calcis, detaching two slips to be attached to it, passes down the metatarsal region and behaves in the same way as in the forelimb.
- *Action:* To extend the hock and flex the digits.
- *Blood supply:* Popliteal artery.
- *Nerve supply:* Tibial nerve.

DEEP LAYER

Popliteus

- This triangular, thick muscle is situated on the upper part of the plantar surface of tibia.
- *Origin:* The lower of the two depressions on the lateral condyle of the femur.
- *Insertion:* The triangular area at the upper third of the posterior surface of tibia limited by the popliteal line.
- *Action:* To flex the stifle and rotate the leg inwards.
- *Blood supply:* Posterior tibial artery.
- *Nerve supply:* Tibial nerve.

Deep digital flexor

- This muscle occupies most of the posterior face of the tibia and is made up of three heads viz.,
    - Superficial (tibialis posterior)
    - Deep (flexor hallucis)
    - Medial (long digital flexor or flexor accessorius) heads.
- *Origin:* Lateral border and posterior face of tibia. Lateral condyle of the tibia and the fibrous cord of the fibula.
- *Insertion:* The tendons of all heads unite above the tarsus and the common tendon passes through *tarsal sheath* and then descends in the metatarsal region. The tendon of the medial head passes under the lateral ligaments of the hock and joins the common tendon of the other two heads at the upper third of the metatarsus. The tendon of the medial head has a synovial sheath at the tarsus. The tendons of superficial and deep heads have a common synovial sheath. The united tendon thus formed comports itself in the same manner as that of the forelimb.
- *Action:* To flex the digits and extend the hock.
- *Blood supply:* Posterior tibial artery.
- *Nerve supply:* Tibial nerve.

MUSCLES OF THE PELVIC LIMB IN HORSE

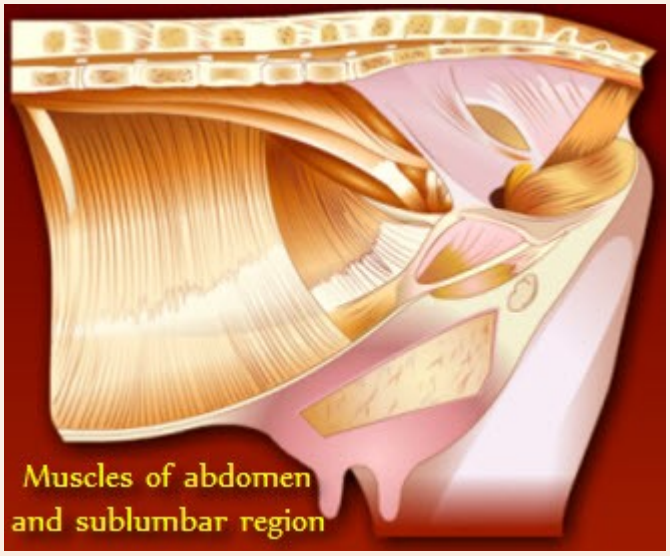
- The *tensor fasciae latae* is less extensive.
- A *superficial gluteus* is more distinct and 'V' shaped. It arises from the lateral angle of the ilium and gluteal fascia and inserted to the third trochanter.
- The *gluteus medius* extends far forwards over the *longissimus dorsi* muscle and is inserted to the trochanter major. It assists in back kick .
- The *gluteus profundus* is smaller and is inserted to the inner face of the convexity.
- The *biceps femoris* has an additional attachment to the femur on the rough surface near the trochanter tertius. It also assists in back kick.
- The *semitendinosus* arises from the transverse process of the first 2 or 3 coccygeal vertebrae.
- The *sartorius* does not arise from the shaft of the ilium.
- The *gracilis* is not so extensively fused to its fellow at the origin.
- The *semimembranosus* is large and arises from the sacro-sciatic ligament also.
- The *obturator internus* have an iliac and sacral part, which has been called as *piriformis*. Its tendon passes through the lesser sciatic foramen and hence does not unite with that of the externus.
- The *articularis* genu may not be seen as a separate muscle.
- The *capsularis* muscle is not found in the ox is present in horse. It arises from the ilium above the origin of the outer part of the rectus femoris. Its tendon passes between *vastus lateralis* and *intermedius* and it inserted to the upper third of the anterior face of the femur and the capsular ligament of the hip. It raises the capsule during flexion of the hip.
- The *long digital extensor* arises in common with the next muscle. It receives a little below the hock on its lateral aspect the tendon of the *lateral digital extensor* and *extensor brevis*.
- The *peroneus tertius* (Tendo femoro-metatarsus) is entirely tendinous. The short wide tendon of insertion of the *tiabialis anterior* to the first tarsal bone is the cunean tendon.
- The *lateral digital extensor* or *peroneus* joins the tendon of the *long digital extensor*.
- The *extensor brevis* joins both the tendons of the long and lateral digital extensor.
- The *peroneus longus* is absent.
- The muscles of the posterior group resemble in general to those of the ox.

MUSCLES OF THE PELVIC LIMB IN DOG

- The *tensor fasciae latae* is thin and long.
- A *superficial gluteus* overlies gluteus medius posteriorly.

- The *gluteus medius* do not go forwards beyond the ilium hence no lumbar part.It is inserted into the trochanter major.
- The *gluteus profundus* is intimately attached to the middle gluteus and is the smaller of the two lying adherent to the ilium.
- The *biceps femoris* has origin from tuber ischii and is placed posteriorly. A thin muscular band which takes its origin from the sacro sciatic ligament and blends with the biceps is known as abductor cruris posterior.
- The *semimembranosus* is clearly divisible into two parts. The anterior part ends under the attachment of the pecteneus.The posterior part is intimately attached to the posterior border of the abductor and terminates on the medial condyle of the femur.
- The *semitendinosus* arises from the tuber ischii and inserts on tibial fascia inside.
- The two parts of the *sartorius* diverge after the origin.
- The *gracilis* is thinner and narrower.
- The adductor is divided into aductor minor and adductor major.Both are inserted to the inner branch of the linea aspersa of the femur.
- The *pecteneus,obturator,quadratus femoris and gemellus,rectus femoris* are similar to the ox.
- The *tibialis anterior* is a large muscle and covers the lateral surface of the common digital extensor at its proximal extrmity.
- The *common digital extensor* is mostly overlapped by the tibialis anterior.It is inserted to the third phalnages of the second,third,fourth and fifth digits.
- The *peroneus longus* has an accessory muscle known as *peroneus brevis*.
- The *soleus* is absent.
- The *gastrocnemeus* has a small sesamoid bone called fabella, embedded into it at its origin.

MODULE-7: MUSCLES OF THE SUBLUMBAR AND ABDOMINAL REGION



LEARNING OBJECTIVES

- To learn the origin, insertion and fibre arrangement in the sublumbar and abdominal regions.
- To understand the boundaries of abdominal cavity both on dorsal, lateral and ventral aspects.
- To understand the flank or paralumbar fossa for clinical examination of abdominal viscera, for trocarising the rumen, for laboratory and other operative procedure of abdomen.
- To learn the vascular supply, nervous innervation, the site of Paravertebral nerve block and tissue biopsy etc.

MUSCLES OF THE SUBLUMBAR REGION

- These are deeply situated in the sublumbar region at the ventral face of the lumbar vertebra and the anterior face of the ilium. These muscles occupy not only the sublumbar region but also extend both forwards and backwards beyond this region, and enter into the formation of the roof of the abdominal cavity. They are in contact with the abdominal viscera.

Fascia

- The ventral face of the iliacus and psoas major is covered by a strong fibrous expansion the iliac fascia**,** which is attached to the tendon of the psoas minor internally and the lateral angle and the border of the ilium laterally.
- It is thin where it covers the anterior part of the psoas major. It also becomes thin posteriorly where it covers the terminal portion of the psoas major and iliacus. Its inferior part furnishes one of the origin of the sartorius.
- The sublumbar muscles are
    - Psoas minor
    - Psoas major
    - Iliacus
    - Quadratus lumborum
    - Intertransversales lumborum
- Psoas minor
    - This is an elongated muscle, which lies along the ventro-lateral aspect of the bodies of the last dorsal and lumbar vertebrae.
    - *Origin:* The intervertebral fibro-cartilage between the 12 th and 13 th and all lumbar vertebrae.
    - *Insertion:* Psoas tubercle on the shaft of the ilium.
    - *Action:* To flex the pelvis on the loin and incline the lumbar region laterally.
    - *Blood supply:* Lumbar arteries.
    - *Nerve supply:* Lumbar nerves.
- Psoas major
    - This muscle is larger than the preceding and is situated ventral to the lumbar transverse processes and ilium.
    - *Origin:* Upper posterior borders of the last two ribs and the transverse processes of the lumbar vertebrae.
    - *Insertion:* In common with the iliacus to the trochanter minor of the femur.
    - *Action:* T o flex the hip and rotate the thigh outwards.
    - *Blood supply:* Lumbar and circumflex iliac arteries.
    - *Nerve supply:* Ilio- psoas nerve.
- Iliacus
    - This muscle is situated on the anterior part of the pelvic surface of the ilium lateral to the ilio-pectineal line. It appears to have two parts forming a groove to receive the preceding muscles with which it forms *iliopsoas*.
    - *Origin:* Iliac surface, shaft of ilium between the psoas tubercle and origin of rectus femoris and tendon of psoas minor and wing of the sacrum. The muscle begins under the body of the sixth lumbar vertebra.
    - *Insertion:* In common with the preceding to the trochanter minor of the femur.
    - *Action:* Same as preceding.
    - *Blood supply:* Lumbar and deep femoral arteries.
    - *Nerve supply:* Ilio- psoas nerve.
- Quadratus lumborum
    - This muscle is partly covered by the *psoas* minor.
    - *Origin:* Ventral surface of the upper part of the last two or three ribs and transverse processes of the lumbar vertebrae.
    - *Insertion:* The anterior border of the first five lumbar transverse processes and wing of sacrum.
    - *Action:* Acting singly, to flex the loin laterally, acting together to fix the lumbar vertebrae and last two ribs .
    - *Blood supply:* Lumbar arteries.
    - *Nerve supply:* Lumbar nerves.
- Intertransversales lumborum
    - These are small, flat muscles fill the inter-transverse spaces of the lumbar vertebrae.
    - *Origin:* The anterior border of the transverse process of the preceding lumbar vertebra.
    - *Insertion:* The posterior border of the transverse process of the lumbar vertebra in front.
    - *Action:* To aid in lateral flexion of loin.

- *Blood supply:* Lumbar arteries.
- *Nerve supply:* Lumbar nerves.

Horse

- The *psoas minor* extends from the last three dorsal vertebrae.
- The *psoas major* completely covers *quadratus lumborum.*
- The *quadratus lumborum* is narrower.
- The iliacus does not arise from the sixth lumbar vertebra and not so closely blended with the psoas major as in the ox.

Dog

- The *psoas minor* is relatively larger than the psoas minor.Its anterior part blends with the quadratus lumborum but does not extend into the thoracic cavity.
- The *psoas major is* short as it begins from third or fourth lumbar vertebra.
- The *quadratus lumborum* is larger and stronger and better developed than any other animals.Itb arises from last three or four thoracic vertebra in common with psoas minor to teminate in the upper part of the pelvic surface of the ilium.
- The intertransversales lumborum is same as that of ox.

MUSCLES OF THE ABDOMEN

- Removal of the skin from the ventral and lateral aspects of the thorax and abdomen exposes the cutaneous muscle of the trunk.

Tunica abdominalis

- This is a yellow elastic sheet - the abdominal tunic underneath the cutaneous muscle.
- It is very thick and closely adherent to the aponeurotic part of the external oblique muscle but closely covers its muscular part.
- It is thick towards the common prepubic tendon of the abdominal muscles and the linea alba.
- It is reduced to a very thin layer as it reaches the muscular portion of the external oblique muscle and thereafter it disappears.
- Anteriorly, it extends over some of the intercostals and the posterior digitations of the serratus thoracis. Posteriorly, it is attached to the external angle of the ilium and lumbo-dorsal fascia.
- The suspensory ligament of the prepuce in the male and the mammary gland in the female is derived from the external face of this tunic.
- It forms the elastic bandage and supports the abdominal muscles in bearing the weight of the viscera.
- The tunic is thin in the young animal but increase in size with the distension of the digestive organs.
- The tunic takes the place of deep fascia.

Next to this tunic are the four abdominal muscles on either side of the linea alba, arranged in layers; these from without inwards.

Prepubic tendon

- This is the tendon of insertion of the two-rectus abdominis muscles and is in the form of very strong and thick band. They are directed upwards and backwards and are inserted to the anterior border of the two pubic bones between the ilio-pectineal eminences. The aponeurosis of the two oblique muscles and the inguinal ligament are inserted into this tendon. It gives origin to a number of fibres of the

pectineus muscle and fused with the medial face of the anterior part of the origin of the gracilis muscle. This attachment to the gracilis serves to depress the lower part of the abdominal wall.

- Cremaster externus
    - This is narrow flat band of muscle detached from the *internal oblique* muscle of the abdomen. It passes into the inguinal *canal* along with the spermatic cord.
    - Origin: Internal oblique muscle and iliac fascia.
    - Insertion: Parietal layer of tunica vaginalis.
    - Action: To raise the tunica vaginalis.
    - Blood supply: External spermatic artery.
    - Nerve supply: External spermatic nerve.

Inguinal canal

- The inguinal canals are paired, slit-like passages through the posterior part of the abdominal floor on either side of the prepubic tendon.
- The anlagen of the canals are present before sex differentiation occurs. They are therefore, equally well developed in both the sexes.
- The term *canal* is misleading in the large quadrupeds.The canals are potential rather than actual and are between the obliquus abdominis muscles.
- The inguinal rings are slit like rather than circular.
- This canal in male, lodges the spermatic cord, tunica vaginalis, external cremaster muscle, external pudic artery, artery of the cord and veins.
- In the female, it is rudimentary and contains the mammary vessels and nerves.
- The *antero-medial* wall of the canal is formed by the posterior part of the internal oblique muscle of the abdomen. A portion of the aponeurosis of the external oblique muscle forms the *postero-lateral wall*. This is the inguinal or poupart's ligament. It is not a separate distinct structure but is the portion of the aponeurosis of the external oblique muscle related to the canal and lies against the medial surface of thigh.
- It presents two openings, internal and external abdominal opening.
- The upper (peritoneal) opening of this canal is called as the internal abdominal ring. The internal abdominal or internal inguinal ring is formed by the free borders of the internal oblique muscle anteriorly and the upper border of the inguinal ligament posteriorly. Its medial angle is formed by the lateral margin of the prepubic tendon. The lateral angle is formed by the attachment of the obliquus abdominis internus muscle to the inguinal ligament. The long axis of the ring is directed forward, outward and upward from the prepubic tendon towards the tuber coxae and has a length of about 15 cm. The opening of the ring, like that of the canal is potential. The weight of the abdominal viscera keeps the internal oblique muscle in contact with the inguinal ligament except where contents of the canal separate the walls.
- The external inguinal ring is a slit-like opening in the aponeurosis of the external oblique muscle of the abdomen and about 15 cm long. Its direction is forward, upward and little downward from the prepubic tendon. The prepubic tendon forms its rounded medial angle. The lateral angle is acute and quite definite.
- The length of the canal measured between the rings varies. At the medial angle it is equal to the thickness of the prepubic tendon i.e. Less than 1.25 cm, and at the lateral angles about 15 cm.
- Structures passing through the canal in both the sexes, are the external pudic artery, vein, the inguinal nerves and lymph vessels. Additional structures in the male are the spermatic cord, tunica vaginalis and the cremaster externus muscle.

Horse

- The *external oblique* muscle is extensive and extends as high upto lumbar transverse processes. The *internal oblique* is less developed.
- The *rectus abdominis* arises from the cartilage of the fourth or fifth rib to the ninth.
- The *transversus abdominis* meets the costal attachment of the diaphragm at its origin.

Dog

- The *tunica abdominalis* muscle is practically absent.
- The *external oblique* is well developed with clear border at aponeurotic end.
- The *rectus abdominis* extends from xiphoid cartilage to join the linea alba.
- The *inguinal canal* in the bitch lodges the round ligament of the uterus enclosed in a tubular process of the peritoneum.

FOUR ABDOMINAL MUSCLES

- The four abdominal muscles on either side of the linea alba, arranged in layers; these from without inwards
    - Obliquus abdominis externus
    - Obliquus abdominis internus
    - Rectus abdominis
    - Transversus abdominis
    - Cremaster externus

Linea alba (white line)

- The rectus abdominis muscle is entirely fleshy and is situated along the floor of the abdomen. The other muscles have a muscular part laterally and an aponeurotic part ventrally.
- The aponeurotic parts of the abdominal muscles of the opposite side meet and form a median fibrous raphe (white fibrous cord), extending from the xiphoid cartilage to the prepubic tendon (the common tendon of all the abdominal muscles), which is inserted to the anterior border of the pubis. This white fibrous cord is the linea alba which shows a little behind its middle, a *cicatrix,* the umbilicus which indicates the position of the umbilical opening of the fetus.

Obliquus abdominis externus (external oblique muscle)

- This is the largest and the most superficial and extensive of all the abdominal muscles. The fibres of this muscle are directed downwards and backwards. It is having muscular and aponeurotic parts.
- *Origin:* The lateral faces of ribs extending from the lower part of the fifth rib to the last rib above its middle and the lumbo-dorsal fascia.
- *Insertion:* Linea alba, prepubic tendon and tuber coxae.
- The aponeurosis of this muscle at its insertion to the prepubic tendon detaches a fibrous expansion - the poupart's or inguinal ligament, which extends upwards and forwards in the medial face of the thigh and is inserted to the lateral angle of the ilium. It forms the posterior wall of the *inguinal canal.* In front of the pubis and about 5 cm from the median line its aponeurosis is perforated by the *subcutaneous* or *external inguinal ring* for the exit of the spermatic cord. The muscular part is attached to the lateral wall of the chest.
- *Action:* Contraction of the muscle tends to reduce the size of the abdominal cavity and put pressure on the abdominal viscera in micturition, defecation, in forced expiration, coughing and parturition; to flex trunk (arch the back); acting singly, to flex the trunk laterally.
- *Blood supply:* Circumflex iliac, intercostal and lumbar arteries.
- *Nerve supply:* Last five or six intercostal and first two lumbar spinal nerves.

Obliquus abdominis internus (internal oblique muscle)

- It is situated under the preceding and consists of *muscular* and *aponeurotic* portions. The aponeurotic part is blended with that of the external oblique muscle. Its fibres are directed downwards, forwards and inwards. It occupies the entire space bound by the last rib, the free extremities of the transverse processes of the lumbar vertebra and the external angle of the ilium.

- *Origin:* Lateral angle of ilium and the adjacent part of the poupart's ligament.
- *Insertion:* Linea alba, prepubic tendon and posterior border of the last rib.
- *Action:* Similar to the preceding.
- The medial part of this muscle forms the anterior wall of *inguinal canal*. The upper opening of this canal, the *abdominal* or *internal inguinal ring,* which is found here, is slit like.
- *Blood supply:* Circumflex iliac, intercostal and lumbar arteries
- *Nerve supply:* First two lumbar and the last thoracic spinal nerves.

Rectus abdominis

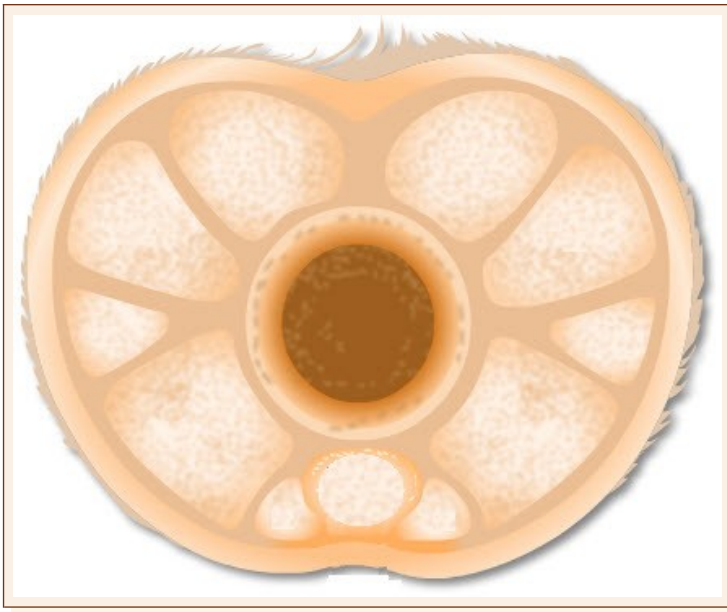
- The muscle is confined to the floor of the abdomen and extends from the sternum to the pubis. The two muscles are separated except at the pelvis by an interval of about 2 to 4 inches so that the abdominal wall here is entirely fibrous. Consisting the aponeuroses of the oblique and transverse muscles and abdominal tunic. It shows on its superficial face five tendinous *inscriptions* (linea transverse) near the second of which, is a foramen for the passage of *subcutaneous abdominal* vein.
- Origin: Ventral and lateral parts of the sternum as forwards as the third costal cartilage.
- *Insertion:* Pubis by means of the prepubic tendon.
- *Action:* Similar to preceding.
- *Blood supply:* Anterior and posterior abdominal arteries.
- *Nerve supply:* The last six or seven thoracic and the first two or three lumbar nerves.

Transversus abdominis

- This is the most medial of the abdominal muscles. It extends from the sternum to pubis and lies between the aponeurotic portion of the internal oblique muscle laterally and that of the transverse abdominis medially. It is a powerful, wide, band-like muscle.
- *Origin:* M edial faces of the cartilages of the asternal ribs and the transverse processes of the first four lumbar vertebrae.
- *Insertion:* Linea alba.
- *Action:* Same as the preceding.
- *Blood supply:* Circumflex iliac, musculo-phrenic and intercostal arteries.
- *Nerve supply:* First two lumbar and the last seven or eight intercostal nerves.

MODULE-8: MUSCLES OF THE BACK, LOIN AND TAIL

	LEARNING OBJECTIVES
	• To study the origin, insertion and action of the muscles in back, loin and tail. • To learn its relation to adjacent structures. • To study about its vascular supply and nervous innervations. • To have a better understanding in respiratory function of muscles of back.



MUSCLES OF THE BACK AND LOINS

The muscles on either side are arranged in five superimposed layers.

- First layer
  - Trapezius thoracis
  - Latissimus dorsi
- Second Layer
  - Rhomboideus thoracis
- Third Layer
  - Serratus dorsalis anterior
  - Serratus dorsalis posterior
- Fourth Layer
  - Longissimus costarum
  - Longissimus dorsi
- Fifth Layer
  - Levatores costarum
  - Multifidus dorsi
  - Intertransversales lumborum

Horse

- The *serratus dorsalis anterior* is more extensive and has eight digitations.
- The *serratus dorsalis posterior* presents seven to eight digitations and the anterior of these overlap those of the serratus dorsalis anterior muscle.
- The *levatores costarum* is of 17 pairs.

Dog

- The *serratus dorsalis* anterior arises from the first six or seven dorsal spines and is inserted from the second to the fifth rib. The muscle is very thick and is well developed.
- The *serratus dorsalis* posterior arises from the lumbo-dorsal fascia. It is inserted to the last three or four ribs thus presenting three or four digitations.

- The *levatores costarum* is similar to the ox and horse but its lumbar part is not depressed for the lodgement of the middle gluteus.
- The other muscles are similar to the ox.

FIRST LAYER

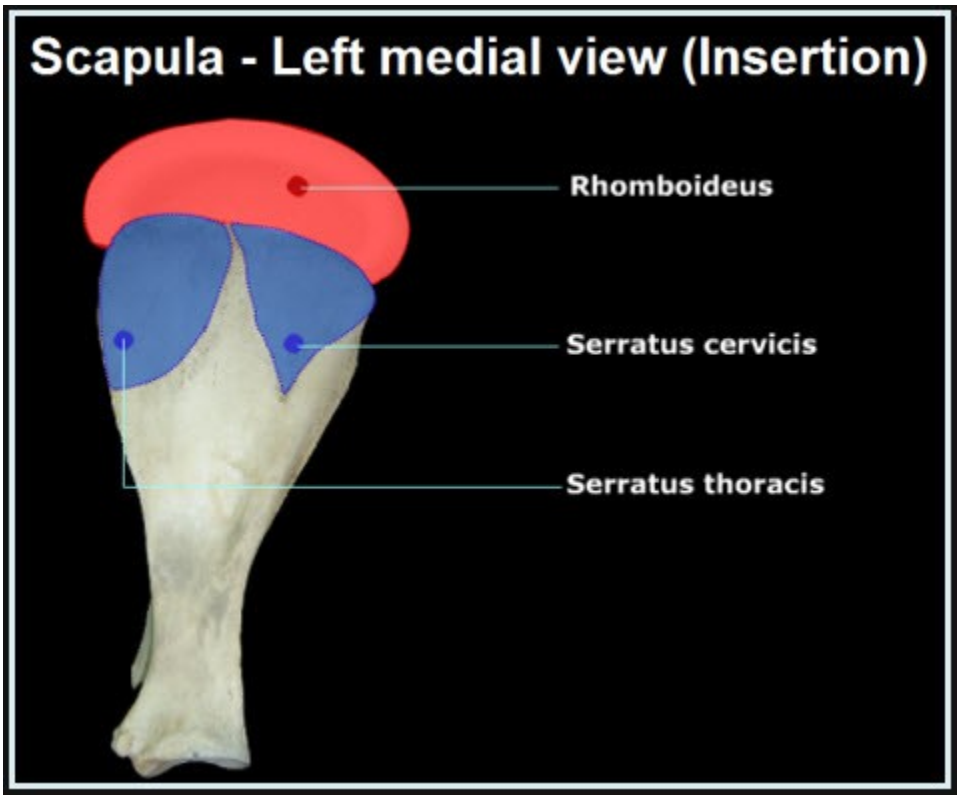
Trapezius thoracis (As described in muscles of pectoral girdle)

Latissimus dorsi

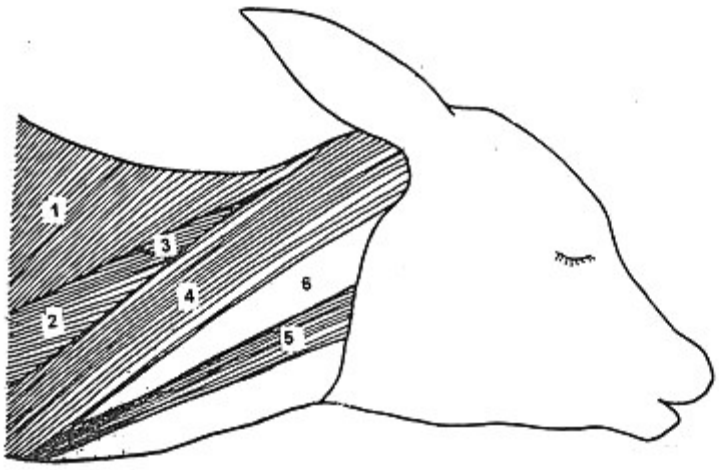
- It is a very wide muscle extending on the lateral wall of the thorax from the dorso-lumbar spine to the arm. It has an aponeurotic origin, which is succeeded by a wide muscular portion.
- *Origin:* Lumbodorsal fascia, 11 th and 12 th ribs and fascia over the intercostal and external oblique muscles.
- *Insertion:* The *anterior part* in common with the *teres major* to the medial (teres) tubercle of the humerus; the *middle part* to the aponeurosis on the deep face of the long head of triceps; the *posterior part* along with the deep pectoral to the medial tuberosity of the humerus. The *tensor fasciae antibrachii* originates *from* the lateral surface of this muscle.
- *Action:* To flex the shoulder joint.
- *Blood supply:* Thoraco-dorsal artery.
- *Nerve supply:* Thoraco-dorsal nerve.

SECOND LAYER

- This muscle extends from ninth to tenth dorsal vertebra to about the level of the middle of the funicular part of the ligamentum nuchae. It is under the cover of trapezius and consists of cervical (rhomboideus cervicis) and dorsal (rhomboideus thoracis) parts
- *Origin:* Ligamentum nuchae, and the spines of dorsal vertebrae from the first to about seventh or eighth
- *Insertion:* The medial surface of the cartilage of the scapula



- *Action:* To draw the shoulder upwards and forwards
- *Blood supply:* Superior cervical and dorsal arteries
- *Nerve supply:* Fifth, sixth, seventh, eighth cervical spinal nerves



Muscles on the lateral aspect of Neck (Superficial dissetion)
1. Trapezius 2. Omotransversarius 3. Spinal accessory nerve (dorsal branch)
4. Brachiocephalicus 5.Sternocephalicus . 6. Jugular furrow

THIRD LAYER

Serratus dorsalis anterior

- This muscle is thin, quadrilateral, flat muscle situated under the rhomboideus thoracis , serratus thoracis and latissimus dorsi. It consists of aponeurotic and fleshy portions.
- *Origin:* Lumbo-dorsal fascia .
- *Insertion:* By three fleshy digitations to the anterior borders and lateral surface of the ribs from the fifth to the seventh.
- *Action:* Inspiratory muscle.
- *Blood supply:* 5^{th} -7^{th} intercostal arteries.
- *Nerve supply:* 5^{th} -7^{th} dorsal spinal nerves.

Serratus dorsalis posterior

- This is a thin, elongated, quadrilateral muscle but wider than the preceding one. It also consists of aponeurotic and fleshy portions.
- *Origin:* Lumbo-dorsal fascia.
- *Insertion:* Posterior borders and lateral surface of the last three ribs.
- *Action:* Expiratory muscle.
- *Blood supply:* 10^{th} -13^{th} intercostal arteries.
- *Nerve supply:* 10^{th} -13^{th} dorsal spinal nerves.

FOURTH LAYER

Longissimus costarum

- This muscle is a long, narrow and thin muscle located along the lateral border of the longissimus dorsi and across the ribs. It has distinct lumbar and costal parts.
- *Origin:* *Lumbar part* from the transverse processes of lumbar vertebrae and the lateral angle of the ilium and the *costal part* from the anterior borders and lateral surfaces of last six or seven ribs.
- *Insertion:* *Costal part* is inserted to the posterior border of ribs from first to the tenth and transverse process of the last cervical vertebra and *lumbar part* is to the posterior border of the last rib.
- *Action:* Expiratory muscle.
- *Blood supply:* Lumbar and intercostal arteries.
- *Nerve supply:* Lumbar and dorsal spinal nerves.

Longissimus dorsi

- This is the longest and most powerful of all the muscles in the body. It extends from the sacrum and the ilium to the middle of the cervical spine. It is situated medial to the preceding and is not distinctly separable from it in the lumbar region.
- *Origin:* Crest and the lateral angle of the ilium, summits of sacral spines, lumbo-dorsal spines and supraspinous ligament.
- *Insertion:* Transverse and articular processes of lumbar vertebrae, transverse processes of dorsal vertebrae and upper surfaces of ribs. Anteriorly about the level of the 7th rib it divides into two parts- the dorsal part (Spinalis et semispinalis) and ventral part (longissmus cervicis) between which emerges the complexus muscle. The *dorsal part* passes under the complexus and is inserted to the neural spines of the last three or four cervical vertebrae and the ventral part is situated to the transverse process of the last cervical vertebrae.
- Three sets of fasciculi are recognized in this muscle:
    - The superficial or spinal fasciculi attached to the spinous process.
    - The deep or transverse fasciculi attached to the articular and transverse processes of the lumbar and transverse process of the thoracic and cervical vertebra;
    - The costal fasciculi turn outwards to become attached to the lateral surface of the ribs.
- *Action:* The two sides of the muscle acts as extensors of the back and loin and singly to flex the spine to the same side. By its attachment to the ribs it acts as an expiratory muscle.

- *Blood supply:* Dorsal, deep cervical, vertebral, intercostal and lumbar arteries.
- *Nerve supply:* Cervical, dorsal and lumbar spinal nerves.

FIFTH LAYER

Levatores costarum

- They are ten or eleven pairs of small, flat, triangular musculo-tendinous fasciculi, which occupy the extreme upper ends of the intercostal spaces. They are blended with the external intercostals at their insertion.
- *Origin:* Transverse process of thoracic vertebrae.
- *Insertion:* Anterior borders of the succeeding rib.
- *Action:* To aid in inspiration.
- *Blood supply:* Intercostal arteries.
- *Nerve supply:* Intercostal nerves.

Multifidus dorsi

- It is a long muscle applied directly to the spinous processes of the vertebra from the sacrum to the neck. It consists of number of segments or bundles, which are directed forwards and upwards. It is continuous in front with the multifidus cervicis and behind with the sacro-coccygeus lateralis.
- *Origin:* Lateral part of sacrum, oblique process of lumbar vertebrae and transverse processes of dorsal vertebrae.
- *Insertion:* Posterior border of neural spines of lumbar and thoracic vertebrae in front.
- *Action:* To extend the back and flex it to a side.
- *Blood supply:* Intercostal and lumbar arteries.
- *Nerve supply:* Dorsal and lumbar spinal nerves.

Intertransversales lumborum

- These are small, flat muscles fill the inter-transverse spaces of the lumbar vertebrae.
- *Origin:* The anterior border of the transverse process of the preceding lumbar vertebra.
- *Insertion:* The posterior border of the transverse process of the lumbar vertebra in front.
- *Action:* To aid in lateral flexion of loin.
- *Blood supply:* Lumbar arteries.
- *Nerve supply:* Lumbar nerves.

MUSCLES OF THE TAIL

- These muscles are situated around the tail enclosed in the strong coccygeal fascia.
- The movements of the tail are effected by five pairs of coccygeal muscles, three of which are longitudinally disposed around the coccygeal vertebrae and thus cover them completely.
- They are composed of series of fasciculi terminating into tendons.
- These muscles gradually diminish in their thickness as they are traced backwards.
- The coccygeal muscles are named as follows
    - Sacro-coccygeus dorsalis (Erector coccygeus)
    - Sacro-coccygeus lateralis (Curvator coccygeus)
    - Sacro coccygeus ventralis (Depressor coccygeus)
    - Intertransversales caudae
    - Coccygeus
    - Recto-coccygeus
- Three sacro-coccygeal muscles are distinguished by their position as *dorsalis, lateralis* and *ventralis.*

- Sacro-coccygeus dorsalis (Erector coccygeus)
    - This muscle is situated on the dorsal aspect of the tail with its fellow on either side of the spines.
    - Origin**:** The last three or four sacral spines and spines of some of the coccygeal vertebrae.
    - Insertion**:** The upper faces of bodies of the coccygeal vertebrae, beyond the third.
    - Action**:** To elevate the tail and to incline it laterally.
- Sacro-coccygeus lateralis (Curvator coccygeus)
    - This muscle is situated lateral to the preceding. It is confounded at its anterior extremity with the multifidus dorsi
    - *Origin**:*** The spinous process of the last lumbar and the transverse process of the sacral and the coccygeal vertebrae.
    - *Insertion**:*** Lateral faces of the vertebrae, except the first three.
    - *Action**:*** To elevate the tail and flex it laterally.
- Sacro coccygeus ventralis (Depressor coccygeus)
    - This muscle is thicker than the dorsalis and situated on the ventral aspect of the tail. It consists of two parts, medial and lateral.
    - *Origin**:*** Transverse process of fifth sacral vertebra.
    - *Insertion**:*** Medial part is inserted to bodies of coccygeal vertebrae. Lateral part is inserted to bodies and transverse processes of coccygeal vertebrae.
    - *Action:* To depress the tail.
- Intertransversales caudae
    - These are situated in the lateral face of the tail between the lateralis and ventralis muscle. It extends from one vertebra to another and thus occupies the inter-transverse spaces.
    - *Origin**:*** The lateral border of the sacrum and the transverse process of preceding coccygeal vertebra.
    - Insertion**:** The transverse process of the first coccygeal and the transverse process of the vertebra behind.
- Coccygeus
    - This muscle is thin, triangular situated against the lateral wall of the pelvis between the sacro-sciatic ligament and the rectum.
    - *Origin**:*** Pelvic surface of the sciatic ligament, near the ischiatic spine.
    - *Insertion**:*** The transverse processes of the second and third coccygeal vertebrae.
- Recto-coccygeus
    - It is large band of plain muscle and detached on either side from the longitudinal layer of the muscular coat of rectum, to the fourth and fifth coccygeal vertebrae
    - *Action**:*** To compress the anus, depress the tail over the perineum and flex the tail laterally.
    - *Blood supply**:*** Middle and lateral coccygeal arteries.
    - *Nerve supply**:*** Coccygeal nerves.

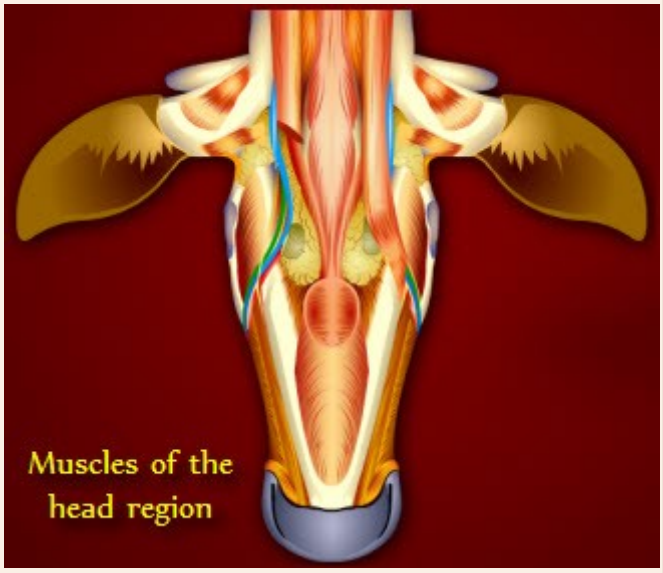
HORSE

- Resemble those of the ox in general.
- The coccygeus is less developed.

DOG

- Resemble those of the ox in general.
- These coccygeal muscles involve in the formation of pelvic diaphragm
- There is an additional sacro-coccygeus which arise on the edge of the sacrum, the transverse process of the first coccygeal vertebra and the posterior border of the ilium.
- The sacro-coccygeus arises from the lumbar vertebrae also.

MODULE-9: MUSCLES OF HEAD REGION - FACIAL, PALPEBRAL AND AURICULAR MUSCLES



LEARNING OBJECTIVES

- To learn the origin, insertion and action of the muscles of face, eyelids and ear.
- To study its relation to adjacent structures.
- To learn its blood supply and nervous innervation.

MUSCLES OF THE HEAD

The muscles of the head are placed around the mouth, nostrils, eyelids, external ear, mandible and hyoid bones. The region of the head may therefore be divided into a number of secondary regions for the study of these muscles as

- Facial region
  - Superficial muscle-cutaneous muscle
  - Muscles of the lips and cheeks
  - Muscles of the nostrils
- Palpebral region (muscles of the eyelids)
- Auricular region (muscles of the external ear)
- Temporo-maxillary region (mandibular muscles -masseter, pterygoid, temporal, etc,)
- Hyoid region- (hyoid muscles)
- Orbital region (ocular muscle)

MUSCLES OF THE FACIAL REGION

The muscles of the facial region are decribed as follows

Superficial muscle /cutaneous muscle

- This is well developed and extensive.
- It covers whole of the frontal region-frontalis muscle.
- The part of the muscle extending over the lower jaw and the masseter and buccinator and blending with the orbicularis oris and in the angle of the mouth it is called as the retractor anguli oris .

The muscles of the lips and cheeks

- Orbicularis oris

- Levator nasolabialis
- Levator labii superioris proprius
- Levator labii superioris proprius accessorius
- Dilator naris lateralis (Caninus)
- Depressor labii superioris
- Zygomaticus
- Incisivus superior
- Incisivus inferior (levator labii inferioris)
- Mentalis
- Buccinator
- Levator buccalis
- Depressor labii inferioris

Muscles of the nostrils

- *Levator naso labialis*
- Dilator naris lateralis
- Dilator naris apicalis
- Dilator naris superioris (dorsal part)
- Dilator naris inferioris (ventral part)

MUSCLES OF THE LIPS AND CHEEKS

The muscles of the lips and cheeks are

- Orbicularis oris
    - It is the sphincter around the anterior opening of the mouth but is incomplete in the muzzle.
    - The muscle is included between the skin and mucous membrane of the lips to which it is intimately adherent. It blends with all the muscles of the face, which converge to the angle of the mouth.
    - *Action:* To close the lips and help in suction and mastication.
    - *Blood supply:* Superior and inferior labial arteries.
    - *Nerve supply:* Facial nerve
- Levator nasolabialis
    - The muscle is thin and extensive and extends in oblique direction from the inferior border of the frontalis muscle to the nostril and the upper lip. It is elongated from above downwards and covers the external face of the nasal region.
    - *Origin:* Frontal and nasal bones.
        - The muscle divides below into two layers - superficial and deep. The superficial part passes over the lateral face of the levator labi superioris proprius and dilator naris lateralis. The deep division is thin, aponeurotic and passes beneath the above said muscles.
    - *Insertion:* Upper lip and lateral part of the nostril.
    - *Action:* To elevate the upper lip and dilate the nostril.
    - *Blood supply:* Facial, dorsal, labial and malar arteries.
    - *Nerve supply:* Facial nerve.
- Levator labii superioris proprius
    - This is a flat, narrow muscle located in the antero-lateral aspect of the face and extending from the facial tuberosity to the upper lip. It is covered partly by the superficial division of the levator naso labialis and the malaris.
    - *Origin:* Facial tuberosity.
    - *Insertion:* By several tendons to the upper lip.
    - *Action:* To elevate the upper lip or to draw it to a side.

    - *Blood supply:* Superior labial artery.
    - *Nerve supply:* Facial nerve.
- Levator labii superioris proprius accessorius
    - This is a narrow muscle, extends infront of the facial tuberosity to the upper lip and which is regarded as accessory to the preceding and lies between the levator labii superioris proprius and the dilator naris lateralis.
    - *Origin:* Facial tuberosity.
    - *Insertion:* By several tendons to the upper lip.
    - *Action:* To assist the preceding muscle.
    - *Blood supply:* Superior labial artery.
    - *Nerve supply:* Facial nerve.
- Dilator naris lateralis (Caninus)
    - This a narrow band placed between the levator labii superioris proprius and depressor labii superioris muscles.
    - *Origin:* Facial tuberosity.
    - *Insertion:* Lateral wing of the nostril.
    - *Action:* To dilate the nostril.
    - *Blood supply:* Superior labial artery.
    - *Nerve supply:* Facial nerve.
- Depressor labii superioris
    - This is a small fusiform muscle situated below the preceding.
    - *Origin:* Facial tuberosity.
    - *Insertion:* Muzzle and upper lip by several tendons.
    - *Action:* To compress the upper lip.
    - *Blood supply:* Superior labial artery.
    - *Nerve supply:* Facial nerve.
- Zygomaticus
    - It is a long strap like muscle located on the side of the face in a downward and forward direction from the zygomatic arch to the upper lip.
    - *Origin:* Zygomatic process of malar bone.
    - *Insertion:* To the buccinator and orbicularis at the angle of the mouth.
    - *Action:* To retract and raise the angle of the mouth.
    - *Blood supply:* Facial artery.
    - *Nerve supply:* Facial nerve.
- Incisivus superior
    - It consists of an indefinite group of fibres extending from the antero-lateral angle of the premaxilla to the deep surface of the upper lip. The action is to pull the lip towards the premaxilla.
    - It is supplied by the superior labial artery and facial nerve.
- Incisivus inferior (levator labii inferioris)
    - It is a small, round muscle lies between the orbicularis of the lower lip and inferior and lateral faces of the body of the mandible to about the level of the fossa containing the mental foramen.
    - *Origin:* Body of the mandible, at the level of the second incisor tooth.
    - *Insertion:* Lower lip.
    - *Action:* To elevate the chin .
    - *Blood supply:* Inferior labial artery.
    - *Nerve supply:* Facial nerve.
- Mentalis
    - This muscle lies in the chin, ventral to the body of the mandible.
    - *Origin:* Body of mandible on either side of the symphysis.
    - *Insertion:* Skin of the chin.
    - *Action:* Wrinkle the skin and pull it forward.
    - *Blood supply:* Mental artery.
    - *Nerve supply:* Mental nerve.

- Buccinator
    - This muscle forms the main mass of the muscular tissue of the cheek and is situated in the side of the face.
    - *Origin:* Alveolar border of the mandible, the lower part of the external surface of the alveolar border of the maxilla.
    - *Insertion:* Angle of the mouth blending with the orbicularis.
    - *Action:* Chiefly mastication. To flatten the cheek, presses the food between the teeth and also to retract the angle of the mouth.
    - *Blood supply:* Facial and buccinator arteries.
    - *Nerve supply:* Facial nerve.
- Levator buccalis
    - *Origin:* Facial part of lacrimal bone
    - *Insertion:* Buccal mucosae, ventral to the facial tuberosity.
    - *Action:* To raise the posterior part of the cheek.
    - *Blood supply:* Malar artery.
    - *Nerve supply:* Superior buccal and sub zygomatic nerve.
- Depressor labii inferioris
    - This muscle lies along the inferior border of the preceding muscle. It is separable from it only at its anterior part.
    - *Origin:* Alveolar border of the mandible, behind the last cheek tooth.
    - *Insertion:* Lower lip.
    - *Action:* To depress the lower lip.
    - *Blood supply:* Ventral labial artery.
    - *Nerve supply:* Facial nerve.

MUSCLES OF THE NOSTRILS

- Levator naso labialis
- Dilator naris lateralis
- Dilator naris apicalis
- Dilator naris superioris (dorsal part)
- Dilator naris inferioris (ventral part)

Levator naso labialis

- The muscle is thin and extensive and extends in oblique direction from the inferior border of the frontalis muscle to the nostril and the upper lip. It is elongated from above downwards and covers the external face of the nasal region.
- *Origin:* Frontal and nasal bones.
    - The muscle divides below into two layers-superficial and deep. The superficial part passes over the lateral face of the levator labi superioris proprius and dilator naris lateralis. The deep division is thin, aponeurotic and passes beneath the above said muscles.
- *Insertion:* Upper lip and lateral part of the nostril.
- *Action:* To elevate the upper lip and dilate the nostril.
- *Blood supply:* Facial, dorsal, labial and malar arteries.
- *Nerve supply:* Facial nerve.

Dilator naris lateralis (Caninus)

- This a narrow band placed between the levator labii superioris proprius and depressor labii superioris muscles.
- *Origin:* Facial tuberosity.
- *Insertion:* Lateral wing of the nostril.

- *Action:* To dilate the nostril.
- *Blood supply:* Superior labial artery.
- *Nerve supply:* Facial nerve.

Dilator naris apicalis

- It is situated in the muzzle.
- *Origin:* Body of the premaxilla.
- *Insertion:* Medial wing of the nostril.
- *Action:* To dilate the nostril.
- *Blood supply:* Naso labial arteries.
- *Nerve supply:* Facial nerve

Dilator naris superioris (dorsal part)

- It is very small, short thin muscle.
- *Origin:* Alar cartilage of the nostril.
- *Insertion:* Medial wings of nostril.
- *Action:* To dilate the nostril.
- *Blood supply:* Facial and infra orbital arteries.
- *Nerve supply:* Facial and infraorbital nerves.

Dilator naris inferioris (ventral part)

- This muscle is arranged in two layers
- *Origin:* Nasal process of premaxilla.
- *Insertion:* Lateral wing of the nostril.
- *Action:* To dilate the nostril.
- *Blood supply:* Facial and infra orbital arteries.
- *Nerve supply:* Facial and infraorbital nerves.

MUSCLES OF THE EYELIDS / PALPEBERAL REGION

They are

- Orbicularis oculi
- Corrugator supercilli
- Malaris
    - Levator buccalis
    - Depressor palpebrae inferioris
- Levator palpebrae superioris

Orbicularis oculi

- It is a well-developed, flat, elliptical sphincter muscle around the eyelids. The muscle fibres are chiefly attached to the skin and the palpebral ligament at the medial canthus.
- *Action:* To close the eyelids.
- *Blood supply:* Alar and frontal arteries.
- *Nerve supply:* Facial nerve.

Corrugator supercilli

- The place of this muscle is taken up in the ox by the lower part of the frontalis muscle around the upper eye-lid.
- *Action:* It raises the upper eye-lid and wrinkles the skin.
- *Blood supply:* Frontal arteries.
- *Nerve supply:* Facial nerve.

Malaris

- It is a broad muscle spreading below the lower eyelid over the buccinator and masseter. It is divisible into an anterior part levator buccalis and a posterior part the depressor palpebrae inferioris.
    - Levator buccalis
        - *Origin:* Facial part of lacrimal bone
        - *Insertion:* Buccal mucosae, ventral to the facial tuberosity.
        - *Action:* To raise the posterior part of the cheek.
        - *Blood supply:* Malar branch of external maxillary artery.
        - *Nerve supply:* Superior buccal and sub zygomatic nerve.
    - Depressor palpebrae inferioris
        - *Origin:* Facial part of lacrimal bone.
        - *Insertion:* Fascia of the dorsal border of the buccinator.
        - *Action:* It is attached to the lower eye-lid. It depresses the lower eyelid.
        - *Blood supply:* a branch from external maxillary artery.
        - *Nerve supply:* Superior buccal and sub zygomatic nerve.

Levator palpebrae superioris

- It is situated with in the orbit above dorsal rectus muscle.
- *Origin:* Pterygoid crest opposite to the optic foramen.
- *Insertion:* Upper eyelid.
- *Action:* To raise the upper eye-lid.
- *Blood supply:* Ophthalmic artery.
- *Nerve supply:* Oculomotor nerve.

MUSCLES OF AURICULAR REGION (EXTERNAL EAR)

The muscles, which move the external ear are divided into *extrinsic* and *intrinsic* groups. The muscles of the former arise from extraneous parts as cranial bones, ligamentum nuchae or parotid gland and are inserted into the cartilages of the ear. The muscles of the latter are confined to the cartilage of the ear. They are

- Extrinsic muscles
    - Parotido-auricularis
    - Cervico-auricularis
    - Parieto-auricularis externus
    - Parieto-auricularis internus
    - Zygomatico-auricularis
    - Temporo- auricularis (Tragicus of horse)
- Intrisic muscles
    - Scuto-auricularis externus
    - Scuto-auricularis internus

EXTRINSIC MUSCLES

Parotido-auricularis

- It is a thin and wide muscle situated on the parotid salivary gland. It is wide below and narrow above.
- *Origin:* Fascia on the lower part of parotid gland.
- *Insertion:* Conchal cartilage below the angle of junction of its borders.
- *Action:* To incline the ear downwards and backwards

Cervico-auricularis

- This muscle is a compound muscle with three parts, namely cervico-auricularis externus, medius and internus, named according to their position at their origin. They are arranged layer by layer.
- *Origin:* Ligamentum nuchae and cervical fascia.
- *Insertion:* Medial face of the base of the concha.
- *Action:* Rotate the ear and draw it backward.

Parieto-auricularis externus

- It is a wide but thin muscle covering the temporalis.
- *Origin:* Frontal crest, parietal and occipital bones.
- *Insertion:* Scutiform cartilage and anterior aspect of concha.
- *Action:* To adduct the concha rotate it forwards to prick the ear

Parieto-auricularis internus

- It is placed partially under the preceding muscle.
- *Origin:* Parietal bone behind the frontal eminence.
- *Insertion:* Medial face of the concha.
- *Action:* To adduct the ear.

Zygomatico-auricularis

- It is made up of two bundles.
- *Origin:* Zygomatic process of the squamous temporal.
- *Insertion:* The upper bundle to the scutiform cartilage and the lower one to the front and base of concha.
- *Action:* To prick the ear.

Temporo- auricularis (Tragicus of horse)

- It is a very thin fasciculus.
- *Origin:* External auditory process and annular cartilage.
- *Insertion:* Base of concha.
- *Action:* To telescope the conchal and annular cartilage and shorten the external acoustic meatus.

INTRINSIC MUSCLE

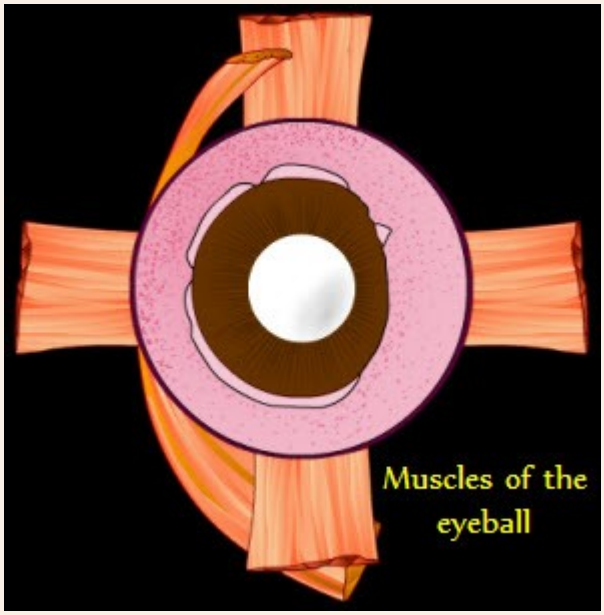
Scuto-auricularis externus

- *Origin:* The outer face of the scutiform cartilage.
- *Insertion:* Medial part of the base of concha.
- *Action:* To prick the ear.

Scuto-auricularis internus

- *Origin:* Internal face of the scutiform cartilage,
- *Insertion:* Anterior aspect of the Concha.
- *Action:* To prick the ear,
- *Blood supply:* External carotid, superficial temporal arteries and a small branch from the occipital artery.
- *Nerve supply:* Facial nerve, first and second spinal nerves.

MODULE-10: MUSCLES OF HEAD REGION - TEMPORO-MANDIBULAR, HYOID AND ORBITAL MUSCLES



LEARNING OBJECTIVES

- To learn the origin insertion and action of the muscles of mandibular region, hyoid and eyeball.
- To study its relation to adjacent structures.
- To learn its blood supply and nervous innervation.

MUSCLES OF TEMPORO-MANDIBULAR REGION

They are the mandibular muscles or muscles of mastication. They are as follows

- Masseter
- Temporalis
- Pterygoideus medialis
- Pterygoideus lateralis
- Digastricus

Masseter

- This muscle is situated on the lateral face of the broad part of the ramus of the mandible.
- *Origin:* Zygomatic arch, facial crest and facial tuberosity.
- *Insertion:* Lateral face and posterior border of the vertical ramus of the mandible.
- *Action:* To close the jaws and move the mandible forward and upward; acting singly to produce lateral motion .
- *Blood supply:* Transverse facial, masseteric, branch from external maxillary and deep temporal arteries.
- *Nerve supply:* Mandibular nerve.

Temporalis

- It is situated in the temporal fossa.
- *Origin:* Rough part of the temporal fossa.
- *Insertion:* Coronoid process of the mandible.
- *Action:* To raise the lower jaw.
- *Blood supply:* Deep temporal artery.
- *Nerve supply:* Mandibular nerve.

Pterygoideus medialis

- This muscle is situated on the medial face of the vertical ramus of the mandible opposite to the masseter.
- *Origin:* Lateral face of perpendicular part of the palatine and pterygoid crest of the Sphenoid.
- *Insertion:* Medial surface of the vertical ramus of the mandible, behind the mandibular foramen.
- *Action:* To raise the lower jaw and acting singly to assist in the lateral movement of the jaw.
- *Blood supply:* One or two pterygoid arteries from the internal maxillary.
- *Nerve supply:* Mandibular nerve.

Pterygoideus lateralis

- It is a small muscle situated lateral to the upper part of the preceding muscle
- *Origin:* Pterygoid process of the sphenoid bone.
- *Insertion:* Medial face of the neck and condyle of the mandible and the articular disc.
- *Action:* To draw the jaw forwards and acting singly to move it to the opposite side.
- *Blood supply:* a branch from mandibular artery
- *Nerve supply*: Mandibular nerve.

Digastricus

- It is a long muscle extending from the paramastoid process to the medial face of the horizontal ramus. It presents two muscular bellies with an intermediate tendon.
- *Origin:* Paramastoid process.
- *Insertion:* Medial face of the horizontal ramus near the ventral border.
- *(Note:* The two anterior bellies are connected by a band situated below the mylohyoideus is called as transversus mandibulae)
- *Action:* To depress the lower jaw.
- *Blood supply:* a branch from external maxillary artery.
- *Nerve supply*: Facial and mandibular nerves.

MUSCLES OF THE HYOID REGION

They are

- Mylo-hyoideus
- Stylo-hyoideus
- Genio-hyoideus
- Occipito-hyoideus
- Kerato-hyoideus
- Hyoideus transversus
- Sterno-thyro-hyoideus
- Omo-hyoideus

Mylo-hyoideus

- The two muscles form a sling for the tongue.
- *Origin:* Medial face of the mandible, below the alveolar bone.
- *Insertion:* Medial fibrous raphe and lingual process of the hyoid bone.
- *Action:* To raise the tongue and hyoid bone.
- *Blood supply:* Sublingual artery.
- *Nerve supply:* Mandibular nerve.

Stylo-hyoideus

- *Origin:* The muscular angle of great cornu of hyoid *bone*.
- Insertion: Lateral extremity of body of hyoid bone.
- *Action:* To draw the tongue and hyoid bone upwards and backwards.
- *Blood supply:* a branch from external maxillary artery.
- *Nerve supply:* Facial nerve (styloid branch).

Genio-hyoideus

- *Origin:* The fossa on the medial face of the ramus of mandible *close* to the symphysis.
- *Insertion:* Body of hyoid.
- Action: To draw the tongue and hyoid forward.
- *Blood supply:* Lingual and sublingual artery.
- *Nerve supply:* Hypoglossal nerve.

Occipito-hyoideus

- This muscle is a thick triangular muscle, which fills the space between the proximal extremity of the great cornu and the paramastoid process.
- *Origin:* Paramastoid process.
- *Insertion:* The posterior border of the muscular angle of the stylohyoid.
- *Action:* To draw the great cornu backward.
- *Blood supply:* Posterior auricular artery.
- *Nerve supply:* Facial nerve.

Kerato-hyoideus

- This is a small triangular flat muscle fills up the angular space between the small and thyroid cornu. It is covered mostly by the hyo-pharyngeus and partly by hyo-glossus.
- *Origin:* Posterior border of small cornu.
- *Insertion:* Dorsal border of the thyroid cornu.
- *Action:* To raise the larynx.
- *Blood supply:* Lingual artery.
- *Nerve supply:* Glosso-pharyngeal nerve.

Hyoideus transversus

- A small-unpaired muscle situated between the two small cornua, enclosed by mucous membrane. It raises the root of the tongue.
- *Blood supply:* Lingual artery.
- *Nerve supply:* Glosso-pharyngeal nerve.

Sterno-thyro-hyoideus

- This is a long, slender muscle situated on the ventral face of the trachea.
- *Origin:* Manubrium sterni.
    - The two *side m*uscles are very close together at their origin and cover trachea at the lower third of the neck. About the *middle* of the neck, each muscles *divide into* two bands-the thyroid and hyoid bands which diverge from those of the opposite *side* from the upper third of the neck. Hence in the upper third of the neck, the ventral face of the trachea is not covered by any muscle. The thyroid band is the larger and the lateral of the two bands.
- *Insertion:* Thyroid band is inserted to the thyroid cartilage of the larynx and the hyoid band to the body of the hyoid and lingual process.
- *Action:* To depress the hyoid, larynx, and tongue during deglutition .
- *Blood supply:* a branch from carotid artery.
- *Nerve supply:* First and second cervical spinal nerves .

Omo-hyoideus

- This is small triangular muscle extending from the neck at its ventro-lateral aspect in an oblique direction upward and forward to the hyoid bone.
- *Origin:* Transverse processes of the third and fourth cervical vertebrae.
    - This muscle passes under the deep face of the brachio-cephalicus and sterno-mastoideus obliquely forwards and inwards laterally over the sterno-mastoideus or passes through the latter and passes forwards in company with the hyoid band of the sterno-thyro-hyoideus.
- *Insertion:* Body of the hyoid bone.
- *Action:* To retract the hyoid and root of the tongue.

MUSCLES OF THE EYE BALL (OCCULAR MUSCLES)

The muscles are enclosed in superficial and deep fasciae. They are seven in number as four straight, one retractor and two oblique muscles. They are as follows

- Rectus superioris (dorsalis)
- Rectus inferioris (ventralis)
- Rectus medialis
- Rectus lateralis
- Retractor oculi
- Oblique superior
- Oblique inferior

Straight muscles

- The straight muscles are named according to their position as Rectus superioris (dorsalis),Rectus inferioris (ventralis),Rectus medialis and Rectus lateralis.
- They also named as per their action as levator, depressor, abductor and adductor oculi.
- These are flat muscular bands arise around the optic foramen, diverge and pass along the corresponding aspects of the eye-ball forward and terminate in fine aponeurotic tendons to be inserted to the fore part of the sclera in front of the equator.
- *Action:* The superior rectus elevates the eyeball or turns it upwards, the inferior rectus depresses the eyeball or turns it downwards, the external rectus abducts the eyeball or turns it outwards and the internal rectus adducts the eyeball or turns it inwards. The four recti acting together will retract the eyeball.

Posterior muscle

- The posterior muscle - retractor oculi is enclosed within the recti muscles and envelops the optic nerve. It is made of four bundles, which arise around the optic foramen and inserted to the posterior part of the sclera behind the recti. The bundles alternate with the recti. Its action is to retract the eyeball into the orbit.

Oblique muscles

- The oblique muscles are two in number-superior and inferior.
- The oblique superior is long and differs from others in having an interrupted course. It has a narrow muscular band and a thin aponeurotic termination. It arises from back of the orbit, at about the ethmoidal foramen and passes forward along the internal wall of the orbit, lying medial to the internal rectus and gains at the level of supraorbital process, a fibro-cartilaginous pulley. It then reflects around this pulley outwards and forwards and passes between the eyeball and dorsal rectus and terminates between the dorsal and lateral recti about half an inch behind the margin of the cornea.
- The oblique inferior muscle is shorter and thicker than the superior and entirely muscular. It arises from the depression behind the lacrimal fossa, curves around the rectus ventralis and is inserted into the sclera near and partly beneath the lateral rectus.
- *Action:* The superior oblique muscle elevates and rotates the eyeball while the inferior oblique depresses and draws the eyeball inwards.
- *Blood supply:* Ophthalmic artery.
- *Nerve supply:* Oculomotor nerve supplies all the muscles except the superior oblique, lateral rectus and the retractor. The trochlear nerve supplies the superior oblique and the abducent nerve supplies the lateral rectus and retractor.

MUSCLES OF THE HEAD - HORSE

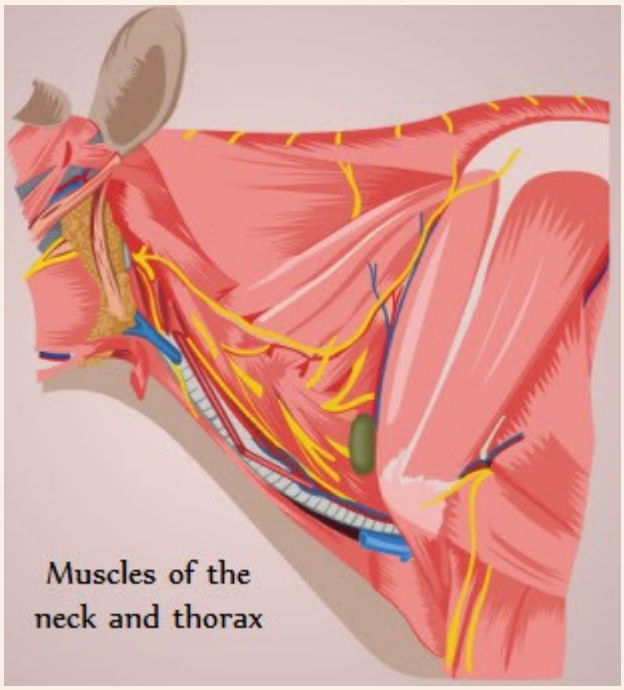
- The *cutaneous muscle* of the head is less developed.
- The *orbicularis oris* is a complete sphincter.
- The *levator labii superioris proprius* inserted by a common tendon with its fellow to the upper lip.
- The *depressor labii superioris* is absent.
- *Transversus nasi* is unpaired and lies between the nostrils.
- The *corrugator supercilli* is a separate muscle.
- *Malaris* is thin and *levator buccalis* is absent.
- There is an additional muscle in the mandibular region the occipito-mandibularis, which extends between the paramastoid process and the posterior border of the vertical ramus
- The *digastricus* has a distinct intermediate tendon, which perforates the tendon of *stylo-hyoideus*.
- *Thyro-arytenoideus* is represented by ventricularis and vocalis.
- Other muscles resemble those of the ox.

MUSCLES OF THE HEAD - DOG

- The *facial cutaneous* is well developed
- The *orbicularis oris* is rudimentary
- The *levator naso labialis* is not divided.
- The *levator labii superioris* terminates by numerous small tendons, some of which unite with those of opposite muscle. And others are inserted in to the nostrils.
- A triangular muscle which originates inferior to the *levator labii superiois* represents the *dilator naris lateralis*. The other dilator muscles of the nostrils are absent.
- The *depressor labii inferioris* is absent.
- The *corrugator supercilli* extends from the fascia of the frontal bone and terminates in the upper eyelid at the medial angle.
- The *masseter* has a remarkable development. It arises from the zygomatic arch and is prolonged beyond the posterior border of the ramus of the manidible. It is thick and its external surface is convex.

- The *temporalis* is rendered stronger due to the large amount of tendinous material it contains. The muscle is larger as temporal fossa is more developed.
- The *lateral pterygoid* is not distinct from the *medial one*.
- The *occipito-mandibularis* is a strong, round muscle.
- The *stylo-hyoideus* is in the form of very slender, pale muscular band and *kerato-hyoideus* is large.
- The *occipito hyoideus* and *hyoideus transversus* are absent.
- The *parotido auricularis* is longer and narrower.
- The *parieto –auricularis externus* is extensive.
- Both the *cervico-auricularis externus and parieto-auricularis internus* divide at their termination into two and these are inserted to both conchal and scutiform cartilage.
- The *sucto-auricularis externus* is not distinct from the *parieto auricularis externus*.
- Other muscles resemble those of the ox.

MODULE-11: MUSCLES OF THE NECK AND THORAX



LEARNING OBJECTIVES

- To study the origin, insertion and arrangement of neck muscles superficially and deep in the lateral and ventral cervical region.
- To learn its relation to adjacent structures.
- To study the vascular supply and nervous innervations.
- To have a better understanding on the movements of the head, forelimb controlled by actions of the neck muscle on the head and forelimb.
- To learn the origin, insertion and action of muscles of thorax in the lateral wall and interior.
- To learn its relation to adjacent structures.
- To study the vascular supply and nervous innervations.

MUSCLES OF THE NECK

The cutaneous muscle is absent in the region of the neck. The cervical muscles may be divided into two groups- *ventral cervical* and *lateral cervical* .

Ventral cervical group (Click here to know more...)

These muscles lie below and lateral to the cervical vertebrae and are for the most part found around the trachea. They are

- Sterno-cephalicus
- Sterno-thyro-hyoideus
- Omo-hyoideus
- Scalenus
- Rectus capitis ventralis major (Longus capitis)
- Rectus capitis ventralis minor (Rectus capitis ventralis)
- Rectus capitis lateralis
- Intertransversales colli (Intertransversari cervicis)
- Longus colli

Lateral cervical group (Click here to know more...)

These muscles lie lateral and dorsal to the cervical vertebrae and are arranged in superimposed layers. They are

- First layer
  - Trapezius cervicalis
  - Brachio-cephalicus
- Second layer
  - Omo-transversarius
  - Rhomboideus cervicalis
- Third layer
  - Serratus cervicis
- Fourth layer
  - Splenius
  - Longissimus capitis *et* atlantis
  - Complexus (semispinalis capitis)
  - Multifidus cervicis (semispinalis of the neck)
  - Obliquus capitis anterior (obliquus capitis cranialis)
  - obliquus capitis posterior (obliquus capitis caudalis)
  - Rectus capitis dorsalis major
  - Rectus capitis dorsalis minor

VENTRAL CERVICAL GROUP

These muscles lie below and lateral to the cervical vertebrae and are for the most part found around the trachea. They are

- Sterno-cephalicus
- Sterno-thyro-hyoideus
- Omo-hyoideus
- Scalenus
- Rectus capitis ventralis major (Longus capitis)
- Rectus capitis ventralis minor (Rectus capitis ventralis)
- Rectus capitis lateralis
- Intertransversales colli (Intertransversari cervicis)
- Longus colli

Sterno-cephalicus

- This muscle consists of two divisions -*sterno-mandibularis* and *sterno-mastoideus*.
- *Origin*:
  - The two divisions arise together from the manubrium sterni and first costal cartilage.

    - On either side the muscles are very close together at their origin and at the lower third of the neck and from the middle of the neck, they diverge.
    - The sterno-mandibularis is the superficial division and it forms the lower boundary of the jugular furrow.
    - The deep division is the sterno-mastoideus.
    - It covers the oesophagus, trachea, and carotid structures and crosses under the superficial division at the upper third of the neck.
- *Insertion:* Superficial division is inserted to the anterior border of the masseter muscle and the angle of the jaw; the deep division is common with the rectus capitis ventralis major to the mastoid process, and the basilar tubercles.
- *Action:* Together to flex the head and the neck and acting singly to incline head and neck laterally.
- *Blood supply:* Common carotid artery.
- *Nerve supply:* Spinal accessory nerve.

TOP

Sterno-thyro-hyoideus

- This is a long, slender muscle situated on the ventral face of the trachea.
- *Origin:* Manubrium sterni.
    - The two *side m*uscles are very close together at their origin and cover trachea at the lower third of the neck. About the *middle* of the neck, each muscles *divide into* two bands-the thyroid and hyoid bands which diverge from those of the opposite *side* from the upper third of the neck. Hence in the upper third of the neck, the ventral face of the trachea is not covered by any muscle. The thyroid band is the larger and the lateral of the two bands.
- *Insertion:* Thyroid band is inserted to the thyroid cartilage of the larynx and the hyoid band to the body of the hyoid and lingual process.
- *Action:* To depress the hyoid, larynx, and tongue during deglutition .
- *Blood supply:* Carotid artery.
- *Nerve supply:* First and second cervical spinal nerves .

TOP

Omo-hyoideus

- This is small triangular muscle extending from the neck at its ventro-lateral aspect in an oblique direction upward and forward to the hyoid bone.
- *Origin:* Transverse processes of the third and fourth cervical vertebrae.
    - This muscle passes under the deep face of the brachio-cephalicus and sterno-mastoideus obliquely forwards and inwards laterally over the sterno-mastoideus or passes through the latter and passes forwards in company with the hyoid band of the sterno-thyro-hyoideus.
- *Insertion:* Body of the hyoid bone.
- *Action:* To retract the hyoid and root of the tongue.
- *Blood supply:* Carotid artery.
- *Nerve supply:* Second cervical spinal nerve.

TOP

Scalenus

- This muscle is situated partly in the posterior part of the cervical region and partly on the antero-lateral part of the thorax. It is made up of two division-dorsal and ventral between which emerge the roots of the brachial plexus.
- *Origin:*

    - The dorsal part-scalenus dorsalis arises from the transverse processes of the fourth to the seventh cervical vertebrae.
    - The ventral part- scalenus ventralis arises from the transverse processes of the fourth to the sixth cervical vertebrae.
    - The dorsal part is covered by the serratus thoracis.
    - The roots of the phrenic nerves traverse the ventral part. The brachial vessels cross its ventral edge.
- *Insertion:* The dorsal part into the fourth rib; ventral part to the anterior border of the first rib.
- *Action:* To flex the neck or incline it laterally. If the neck is fixed, acts as an inspiratory muscle.
- *Blood supply:* Vertebral and intercostal arteries.
- *Nerve supply:* Cervical spinal nerves.

TOP

Rectus capitis ventralis major (Longus capitis)

- This muscle extends from the neck to the basi occipital.
- *Origin:* Transverse processes of the 2 nd to 6 th vertebrae.
- *Insertion:* Basilar tubercle.
- *Action:* To flex the head or incline it laterally.
- *Blood supply:* Vertebral and occipital arteries.
- *Nerve supply:* Cervical spinal nerves.

TOP

Rectus capitis ventralis minor (Rectus capitis ventralis)

- This is a small muscle placed partly above, partly below and external to the preceding (This muscle and the next should be examined in a median sagittal section of the head).
- *Origin:* Ventral surface of the exterior of the wing of atlas.
- *Insertion:* Basilar tubercle.
- *Action:* To flex the occipito-atlantal joint.
- *Blood supply:* Occipital artery.
- *Nerve supply:* First cervical spinal nerve.

TOP

Rectus capitis lateralis

- This is smaller than the preceding and is under the cover of obliquus capitis anterior.
- *Origin:* The atlas, lateral to the origin of the obliquus capitis anterior.
- *Insertion:* Paramastoid process.
- *Action:* To flex the occipito-atlantal joint.
- *Blood supply:* Occipital artery.
- *Nerve supply:* First cervical spinal nerve.

TOP

Intertransversales colli (Intertransversari cervicis)

- These are six in number. This occupies the space between the articular and transverse processes of the cervical vertebrae. In general, there is a muscle for each joint. Each muscle has dorsal and ventral parts. Origin and insertions are not recognized.

- Attachment: The dorsal bundles extend from the upper part of the transverse process to the anterior articular process of the preceding vertebra. The deeper part of the ventral bundles extends between the ventral parts of the transverse process. Their superficial fibres unite to form a long muscle-intertransversarius longus-whose anterior attachment is to the lateral border of atlas.
- *Action:* To flex the neck laterally.
- *Blood supply:* Vertebral artery.
- *Nerve supply:* Cervical spinal nerves except the first and the last.

TOP

Longus colli

- This is a long muscle extending from the sixth dorsal vertebra to the atlas. It is situated on the ventral aspect of the bodies closely applied against its fellow. It consists of thoracic and cervical parts.
- *Origin:* Bodies of the first six dorsal vertebrae to the medial surface of transverse process of the cervical vertebrae.
- *Insertion:* The thoracic part is inserted to the bodies and transverse processes of the last two cervical vertebrae. The cervical part is inserted to the bodies of the cervical vertebrae and the ventral tubercle of atlas.
- *Action:* To flex the neck.
- *Blood supply:* Subcostal and vertebral arteries.
- *Nerve supply:* Cervical and dorsal spinal nerves.

LATERAL CERVICAL GROUP

These muscles lie lateral and dorsal to the cervical vertebrae and are arranged in superimposed layers. They are

(View the lateral neck region)

First layer

Trapezius cervicalis

- It is a broad triangular muscle extending along the dorsal midline from the level of atlas to the end of the thoracic region, and covers a part of the shoulder. It consists of *cervical*and *dorsal* parts.
- *Origin:* Ligamentum nuchae and supraspinous ligament from the level of the atlas to the twelfth dorsal vertebra.
- *Insertion:* The tuberous part of the spine of the scapula and the scapular fascia.
- *Action:* To elevate the shoulder as a whole. The cervical part draws it forwards and the dorsal part backwards.
- *Blood supply:* Deep cervical, dorsal and intercostal arteries.
- *Nerve supply:* Spinal accessory nerve.

Brachio-cephalicus (View the first layer of Lateral neck muscles)

- This muscle extends from the head, along the neck to the arm. Its upper border is in close apposition with the trapezius and the lower border forms the upper boundary of the jugular furrow. It consists of a dorsal part *cleido-occipitalis* and a ventral part *cleido-mastoideus,* the division being indicated by the position of exit of cutaneous branches of the ventral divisions of the cervical spinal nerves.
- *Origin: Dorsal part* - occipital bone, ligamentum nuchae. *Ventral part* - mastoid process, wing of atlas and the mandible.
- *Insertion:* The united portion of the two divisions is inserted along with the anterior superficial pectoral to the anterior edge of the humerus.
- *Action:* When the head and neck are fixed, to draw the limb forwards and extend the shoulder joint; when the limb is fixed, the two side muscles together extend the head and neck. Each side muscle acting by itself to incline the head and neck to its own side.
- *Note:* The deep face of the muscle receives at the lower part of the neck a small bright red fasciculus of muscle, which arises from the cartilage of the first rib. This is the vestige of subclavius of man.
- *Blood supply:* Inferior cervical, carotid and vertebral arteries.
- *Nerve supply:* Cervical spinal and axillary nerves.

TOP

Second layer

Omo-transversarius

- This muscle extends from the level of the atlas to the shoulder and most part covered by the preceding muscle except at the scapular portion where it is seen as a broad, flat muscular band.
- *Origin:* Wing of atlas and transverse process of the axis.
- *Insertion:* Scapular spine and scapular fascia.
- *Action:* To pull the lower angle of the scapula forwards and upwards and to tense the scapular fascia.
- *Blood supply:* Superior and inferior cervical arteries.
- *Nerve supply:* Cervical spinal nerves.

Rhomboideus cervicalis

- This muscle extends from ninth to tenth dorsal vertebra to about the level of the middle of the funicular part of the ligamentum nuchae. It is under the cover of trapezius and consists of cervical (rhomboideus cervicalis) and dorsal (rhomboideus thoracalis) parts.
- *Origin:* Ligamentum nuchae, and the spines of dorsal vertebrae from the first to about seventh or eighth.
- *Insertion:* The medial surface of the cartilage of the scapula.
- *Action:* To draw the shoulder upwards and forwards.
- *Blood supply:* Superior cervical and dorsal arteries.
- *Nerve supply:* Fifth, sixth, seventh, eighth cervical spinal nerves.

TOP

Third layer

Serratus cervicis

- It is a large, thick muscle extends from the level of the second cervical vertebra to the fifth rib. The posterior part of this muscle is overlapped by the two anterior digitations of the succeeding. It lies partly on the neck and partly on the lateral wall of the thorax.
- *Origin:* From the transverse process of the second or third cervical vertebra to seventh cervical vertebra and the lateral face of ribs from first to the fifth rib.
- *Insertion:* The triangular rough area at the dorso-anterior part of the ventral surface of the scapula.
- *Action:* To pull the scapula towards the neck. Two side muscles acting together to extend the neck and singly inclines the neck to its own side.
- *Blood supply:* Superior cervical, dorsal and vertebral arteries.
- *Nerve supply:* Fourth, fifth and sixth cervical spinal nerves and long thoracic nerve.

TOP

Fourth layer (View the lateral neck muscles)

Splenius

- It is a triangular muscle.
- *Origin:* The summits of first three or four dorsal spines.
- *Insertion:* Occipital, transverse processes of the first three cervical vertebrae in common with the omo-transversarius, cleido-occipitalis and longissimus capitis *et* atlantis.
- *Action:* To elevate and extend the head and neck or incline towards the neck.
- *Blood supply:* Deep cervical artery.
- *Nerve supply:* Cervical spinal nerves except the first two.

Longissimus capitis *et* atlantis

- These are two parallel muscular bundles on the deep face of the splenius. The upper most medial part is longissimus capitis and is overlapped by the lower lateral part, the longissimus atlantis.
- *Origin:* Transverse process of the first two dorsal and the articular processes of the cervical vertebrae except the first two or three.
- *Insertion:* Mastoid process and wing of atlas.
- *Action:* Similar to preceding.
- *Blood supply:* Deep cervical and vertebral arteries.
- *Nerve supply:* Cervical spinal nerves except the first two.

Complexus (semispinalis capitis)

- This muscle is covered by the splenius and partly by the longissimus capitis *et* atlantis. It lies lateral to the ligamentum nuchae.
- *Origin:* Spines of the second, third and fourth dorsal vertebrae, transverse processes of the first ten dorsal vertebrae and articular processes of last five cervical vertebrae.
- *Insertion:* Occipital bone lateral to the insertion of ligamentum nuchae.
- *Action:* Chief extensor of the head and to incline it laterally.
- *Blood supply:* Deep cervical and occipital arteries.
- *Nerve supply:* Cervical spinal nerves.

Multifidus cervicis (semispinalis of the neck)

- This muscle is made up of oblique bundles, which are placed between the complexus and longissimus capitis et atlantis externally and the lamellar portion of the ligamentum nuchae and the superior division of the cervical portion of the longissimus dorsi internally. It lies over the first thoracic and last five cervical vertebrae.
- *Origin:* Posterior articular processes of the last five cervical.
- *Insertion:* Spines and posterior articular processes of preceding cervical vertebrae.
- *Action:* Extend the head or flex it laterally.
- *Blood supply:* Deep cervical and vertebral arteries.
- *Nerve supply:* Cervical spinal nerves, except the first two.

Obliquus capitis anterior (obliquus capitis cranialis)

- This is a quadrilateral muscle situated on the side of the occipito-atlantal joint.
- *Origin:* Interior edge and ventral surface of the wing of atlas.
- *Insertion:* Paramastoid and mastoid processes.
- *Action:* To extend the head on the atlas and flex the head to a side.
- *Blood supply:* Occipital artery.
- *Nerve supply:* First cervical spinal nerve.

Obliquus capitis posterior (obliquus capitis caudalis)

- It is thick, quadrilateral muscle situated chiefly over the wing of the atlas and axis.
- *Origin:* Posterior oblique process and spine of the axis.
- *Insertion:* Dorsal face of the wing of atlas.
- *Action:* Rotate the atlas and with it the head to one side.
- *Blood supply:* Occipital artery.
- *Nerve supply:* Second cervical spinal nerve.

Rectus capitis dorsalis major

- It is a narrow, elongated muscle lies under the complexus lateral to the funicular part of the ligamentum nuchae and extends from the axis to the occipital bone along the dorsal median line closely applied to the fellow of the opposite side .
- *Origin:* Spine of the axis.
- *Insertion:* Occipital bone, near the external occipital protuberance.
- *Action:* To extend the head.
- *Blood supply:* Occipital artery.
- *Nerve supply:* Second cervical spinal nerve.

Rectus capitis dorsalis minor

- This muscle is very small and lies under the preceding.
- *Origin:* Dorsal arch of the atlas.
- *Insertion:* Occipital bone between the external occipital protuberance and foramen magnum.
- *Action:* To assist the preceding.
- *Blood supply:* Occipital artery.
- *Nerve supply:* First cervical spinal nerve.

MUSCLES OF THE NECK - HORSE

- A *cutaneous colli* is present.
- The *sterno-mandibualaris* alone represents *sternocephalicus*.
- The *sterno-thyro-hyoid* is a digastric muscle . The hyoid band is larger and is closely applied to its fellow till its insertion.
- The *scalenus dorsalis* is less extensive.
- The *omo-hyoideus* (also called *subscapulohyoideus*) arises from the subscapular fascia.

MUSCLES OF THE NECK - DOG

- The *cervical part* of the cutaneous muscle is present
- The *sterno-cephalicus* is well developed.
- The *omo-hyoideus* is absent.
- The *scalenus* is very long.
- The *rectus capitis ventralis major* arises from the transverse processes of the second to the 6th cervical vertebra.
- The *spleneus* is extensive.
- The *complexus* consists of two parts.

MUSCLES OF THE THORAX

The muscles of respiration attached to the thoracic vertebrae, ribs and their cartilages and sternum constitute the muscles of the thorax or the costal region. They are

- Serratus thoracis (as described in muscles of pectoral girdle)
- Levatores costarum
- External intercostals
- Internal intercostals
- Retractor costarum
- Rectus thoracis
- Transversus thoracis
- Diaphragm

Levatores costarum

- These constitute a series of 10-12 small, flat, triangular musculo-tendinous fasciculi located at the upper part of the intercostal spaces. They are blended with the external intercostals at their insertion.
- *Origin:* Transverse process of the thoracic vertebrae.
- *Insertion:* Anterior borders of the succeeding.
- *Action:* To aid in inspiration.
- *Blood supply:* Intercostal arteries.
- *Nerve supply:* Intercostal nerves.

TOP

External intercostals

- These muscles fill up the intercostal spaces from the levatores costarum to the level of the distal extremity of the ribs, but do not extend into the interchondral spaces.
- *Origin:* Posterior border of a rib.
- *Insertion:* Anterior border and external surface of the rib behind. The fibres of this muscle are directed downwards.

- *Action:* Inspiratory muscle.
- *Blood supply:* Intercostal arteries.
- *Nerve supply:* Intercostal nerves.

TOP

Internal intercostals

- These muscles are situated internal to the external intercostals and also extend into the interchondral spaces.
- *Origin:* Anterior border of a rib and its cartilage, except the first.
- *Insertion:* Posterior border of the rib in front, and its cartilage. The fibres are directed downward and forward.
- *Action:* Assists in expiration, especially forced expiration.
- *Blood supply:* Intercostal and internal thoracic arteries.
- *Nerve supply:* Intercostal nerves.

TOP

Retractor costarum (retractor of the last rib)

- It is a small triangular muscle situated behind the last rib under the cover of the last digitation of the serratus dorsalis posterior.
- *Origin:* Transverse processes of the first two or three lumbar vertebrae.
- *Insertion:* Posterior border of the last rib.
- *Action:* To retract the last rib and aid in forced expiration.
- *Blood supply:* 1 st –4 th lumbar arteries.
- *Nerve supply:* 1 st -4 th lumbar spinal nerves.

TOP

Rectus thoracis

- This is a thin quadrilateral muscle lying on the lateral face of the first few ribs and their cartilages under the cover of deep pectoral.
- *Origin:* Lower half of the lateral surface of the first rib.
- *Insertion:* Third or fourth costal cartilage.
- *Action:* Assist in inspiration.
- *Blood supply:* Internal and external thoracic arteries .
- *Nerve supply:* First five intercostal nerves.

TOP

Transversus thoracis (triangularis sterni)

- This is a flat, triangular muscle situated on the dorsal face of the sternum.
- *Origin:* Sternal ligament.
- *Insertion:* Cartilages of ribs from the second to the eighth and the adjacent parts of ribs .
- *Action:* Assists in expiration.
- *Blood supply:* Internal thoracic artery.
- *Nerve supply:* Intercostal nerves.

TOP

Diaphragm

- This is a broad and large dome shaped, unpaired muscle, which forms the partition between the thoracic and abdominal cavities.
- Its thoracic surface is convex and is covered by pleura and the abdominal surface is concave and is covered by peritoneum**.**
- Anteriorly the diaphragm is covered by the pleura and is related to the diaphragmatic lobes of the lungs and the last six ribs in part.
- Posteriorly, it is covered by the peritoneum and is related to the rumen, spleen, reticulum, liver, omasum, kidneys and adrenals.
- The muscle presents a tendinous centre, a muscular rim (*costal and sternal parts*) and two crura (*lumbar part*).
- *Attachments**:***
    - The costal part is attached in a straight line from the last rib about a hand's breadth above its middle to the junction of the eighth rib, and its cartilage. It consists of a series of digitations.
    - The sternal part is attached along the cartilage of the eighth rib and across the abdominal face of the xiphoid cartilage.
    - The lumbar part consists of the *right* and *left crura*. Each is fleshy and followed by a tendon attached to the lumbar vertebrae.
    - The *right crus* is attached to the body of the first lumbar vertebra through the ventral longitudinal ligament while *the left* is attached to the first two lumbar vertebrae through the ventral longitudinal ligament. The *right crus* is the larger of the two. It divides into two branches, which circumscribe the hiatus oesophagi, unite below and then spread out to the aponeurotic center. This hiatus is a little left to the median line. The aponeurotic centre is partially divided into right and left parts by the descent of the crura into it.
- The diaphragm is pierced by the three foramina
    - The hiatus aorticus that lies between the two crura below the 13 th thoracic vertebra and transmits the aorta, vena hemiazygos and the cisterna chyli.
    - The hiatus oesophagi is formed between the two divisions of the right crus and transmits the oesophagus and the dorsal and ventral oesophageal continuations of the vagus nerve and
    - The foramen vena cavae is situated a little below and to the right of the hiatus oesophagus and transmits the posterior venacava.
- *Action**:*** Chief inspiratory muscle.
- *Blood supply:* Phrenic and musculo -phrenic arteries.
- *Nerve supply**:*** Phrenic nerve.

TOP

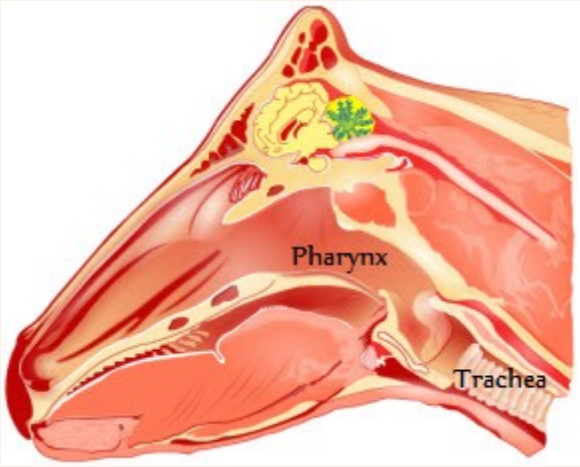
Horse

- *External intercostals* are thinner.
- *Internal intercostals* are also thinner.
- The *transverse thoracis* is inserted to the seven sternal cartilages from the second to the eighth.
- Diaphragm is less wide but more sloping. The right crus does not divide into two branches. The hiatus oesophagi is found in the right crus a little above its junction with the aponeurotic centre. The foramen vena cavae is placed little higher than that in the ox.

Dog

- Diaphragm is strongly curved and its aponeurotic centre is small. The sternal part of the diaphragm has the pericardium attached to it by pericardio-phrenic ligament.
- The other muscles mostly resemble ox.

MODULE-12: MUSCLES OF THE TONGUE, SOFT PALATE, PHARYNX AND LARYNX



LEARNING OBJECTIVES

- To learn the origin, insertion and action of muscles in tongue, soft palate, pharynx and larynx.
- To learn its relation to adjacent structures.
- To study the vascular supply and nervous innervation.
- To have a better understanding in the actions of tongue, soft palate, pharynx and larynx during mastication, prehension, swallowing, breathing etc.

MUSCLES OF THE TONGUE

- The lingual muscles are extrinsic and intrinsic.

Extrinsic muscles

- Stylo-glossus
- Hyoglossus
- Palatoglossus
- Genio-glossus
    - Stylo-glossus
        - It is a long muscle on the ventro-lateral face of the tongue.
        - *Origin:* Great cornu of the hyoid bone, near its anterior extremity.
        - *Insertion:* It terminates near the tip of tongue by blending with the fellow of the opposite side and the intrinsic musculature.
        - *Action:* To retract the tongue and draw it to a side.
    - Hyoglossus
        - It is a wide flat muscle arising from the body and root of the tongue. It retracts and depresses the tongue.
    - Palatoglossus
        - It is a narrow, thin muscle arising from the edge of the soft palate. It passes downwards, blends with the middle hyoglossus and ends on the root of the tongue. This muscle narrows the isthmus faucium
    - Genio-glossus
        - It is a fan shaped muscle, which arises from the medial face of the ramus of the mandible just behind the symphysis and its fibres pass up to the body and root of the tongue. It retracts, depresses and protracts the tongue.
        - *Blood supply:* Lingual and sublingual arteries.
        - *Nerve supply:* Hypoglossal nerves.

Intrinsic muscles

- The intrinsic are bundles of muscle fibres running in different directions and form the bulk of the tongue. They blend with the former.

MUSCLES OF THE SOFT PALATE

They are

- Palato-glossus (as described in muscles of tongue)
- Palato-pharyngeus
- Tensor palati
- Levator palati
- Palatinus

Palato-Pharyngeus

- It is placed next to the glandular layer of the posterior half of the soft palate and becomes continuous with the muscle of the opposite side.
- It extends downwards and backwards to the lateral wall of the pharynx,lying external to the posterior pillar and inserted into the thyroid cartilage.
- It tenses the soft palate and elevates pharynx and draws larynx and oesophagus towards the root of the tongue.

Tensor palati

- It arises from the muscular process to the petrous temporal.
- It passes lateral to the levator palati and its tendon gets reflected around the hamulus of the pterygoid bone and spreads in the soft palate. It tenses the palate.

Levator palati

- *Origin:* Muscular process of petrous temporal.
- *Insertion:* Soft palate.
- *Action:* To raise the soft palate towards the root of the pharynx. and to close the posterior nares during deglutition.

Palatinus

- It is a small-elongated bright red fasciculus lying along with its fellow enclosed in the palatine aponeurosis. It arises from the posterior border of the bony palate and is inserted to the aponeurosis near the free border of the soft palate, It shortens the soft palate.
- *Blood supply:* Lesser palatine arteries.
- *Nerve supply:* Vagus, Glosso-pharyngeal and trigeminal nerves.

MUSCLES OF THE PHARYNX

- They form the muscular wall of the pharynx. Theses are described below.

Stylo- pharyngeus

- Arises from the great cornu or hyoid bone, near its dorsal extremity.
- It is the dilator of the pharynx.

Palato-pharyngeus

- Arises from the vertical part of the palatine and body of the sphenoid bones.
- It shortens the pharynx.

Pterygo-pharyngeus

- Arises from the pterygoid process.
- It shortens the pharynx.

Aryteno-pharyngeus

- Small muscle arises from the posterior aspect of the arytenoid cartilage.

Hyo-pharyngeus

- Arises from the thyroid cornu of the hyoid bone.

Thyro-pharyngeus

- Arises from the lamina of thyroid cartilage.

Crico-pharyngeus

- Arises from the lateral part of the arch of the cricoid cartilage.
- *Action of the last three muscles:* Constriction of the pharynx.
- *Blood supply:* Common carotid, external carotid and external maxillary arteries.
- *Nerve supply:* Fifth, ninth and tenth cranial nerves.

MUSCLES OF THE LARYNX

These are *extrinsic* and *intrinsic*.

- Extrinsic
  - Sterno-thyro- hyoideus
  - Thyro-hyoideus (hyothyroideus)
  - Hyo-epiglotticus
- Intrinsic
  - Crico-thyroideus
  - Crico-arytenoideus dorsalis
  - Crico-arytenoideus lateralis
  - Arytenoideus transversus
  - Thyro-arytenoideus

EXTRINSIC MUSCLES

- Sternothyro- hyoideus (as described in muscles of neck -ventral group).
- Thyro-hyoideus
  - Thyro-hyoideu (hyothyroideus) which extends between thyroid cartilage and the body and the thyroid cornua of the hyoid bone.
  - It draws the larynx downwards and forwards.

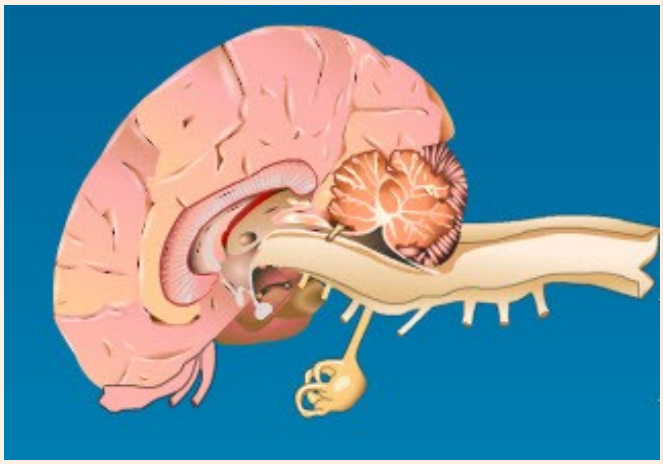
    - It is supplied by anterior laryngeal artery and anterior laryngeal branch of the vagus.
- Hyo-epiglotticus
    - Hyo-epiglotticus is a small bifid muscle enclosed in the glosso-epiglottic fold.
    - It arises from the body and the two small cornua and is inserted to the ventral half of the anterior face of the epiglottis.
    - It draws the epiglottis towards the root of tongue.
    - *Blood supply:* Lingual artery.
    - *Nerve supply:* Hypoglossal nerve.

TOP

INTRINSIC MUSCLES

- Crico-thyroideus lies on the posterior part of the lateral surface of the larynx. It extends from the attachment of cricoid cartilage to the posterior cornu of the thyroid cartilage. It draws the thyroid cartilage and ventral part of cricoid cartilage together and tense the vocal folds in this action. The posterior laryngeal artery and anterior laryngeal nerve supply it.
- Crico-arytenoideus dorsalis is on the dorsal surface of the cricoid cartilage. It extends between the lamina of cricoid and the muscular process of the arytenoid cartilage. It dilates the glottis and abducts the vocal process and fold. The posterior laryngeal artery and the posterior laryngeal nerve supplies the muscle.
- Crico-arytenoideus lateralis is on the deep surface of the thyroid cartilage. It extends from the upper part of cricoid to the muscular process of the arytenoid cartilage. It closes the glottis by rotating the arytenoid cartilage medially. It is supplied by the posterior thyroid artery and posterior laryngeal nerve
- Arytenoideus transversus is unpaired and lies on the dorsal face of the bodies of the arytenoid cartilage, between their lateral borders. It narrows the glottis. It is supplied by posterior laryngeal artery and posterior laryngeal nerve.
- Thyro-arytenoideus extends from the medial face of lamina of thyroid cartilage to the muscular process of the arytenoid. It closes the glottis and slackens the vocal folds.
- *Blood supply and Nerve supply:* Same as the preceding.

MODULE-13: NEUROLOGY



LEARNING OBJECTIVES

- This lesson introduces you about the study of nervous system, the brain and spinal cord. It brief about the menings of the brain and spinal cord.
- To study the detail of cerebrum and various cortical centres of brain
- To learn about the different portions of the brain stem and the structure seen.
- It will help the neurologist to examine the functioning of brain and spinal cord.

	• It gives better understanding on circulation of CSF in the meninges of brain and spinal cord.

INTRODUCTION TO NEUROLOGY

- Neurology is the study of nervous system. This system is a complex mechanism by which the organism is brought into functional relation with the environment and the functions of the various systems are co-ordinated.
- The activity of the nervous system controls two spheres of activity. It is through the nervous system that the animal is enable to react to alterations in the external environment and to various external stimuli. The part of the nervous system controlling this is known as the somatic component and it is through the nervous system that all the other systems in the body are co-ordinated, so that their activities are directed towards the benefit of the organism as a whole and this part is termed as the visceral component of the autonomic nervous system.
- The somatic component is responsible for the transmission of impulses from the somatic receptors and its reactions in the locomotor apparatus of the body. These somatic receptors consist of various types of end organs which are concerned with transmission of
    - Exteroceptive impulses like pain, pressure, tactile sense and temperature
    - Proprioceptive impulses from muscles, tendons and joints
    - Special senses of vision, hearing and equilibrium. The effector part consists of the cranial nerves or the motor cells in the ventral gray column of spinal cord and their axons that terminate in the motor end plates in the skeletal muscles.
- The visceral or splanchnic component controls the activities of secretary glands, plain musculature and cardiac muscle. The receptor part deals with perception of visceral pain and other sensations like those of hunger, thirst and the special senses like gustatory and olfactory function.
- For descriptive purposes, the nervous system is divided as follows:

Nervous System

- Central Nervous System (CNS)
- Peripheral Nervous System (PNS)
- Brain, Spinal cord - Cranio spinal Autonomus Nervous System (ANS)
- Cranial Spinal -Sympathetic, Parasympathetic nerves (Thoracolumbar) (Cranio sacral)

THE CEREBROSPINAL SYSTEM

- It comprises of the central and peripheral nervous system. The central nervous system consists of brain and spinal cord. The peripheral nervous system includes the cranial and spinal nerves and visceral peripheral system.The visceral peripheral system or autonomus nervous system (ANS) is the visceral part of the nervous system.Its peripheral compomants are thoracolumabr and craniosacral outflows and central components of this system are placed within the CNS.
- The two substances called gray mater and white mater enters in the formation of central nervous system. The gray mater is brownish in colour, softer and more vascular and composed chiefly of nerve cells. The white mater is white in colour and composed of medullated nerve fibres.
- As both of the gray and white mater are fragile and soft, they are well protected against injuries by the meninges, skull and the vertebral column.
- The nerves are named according to their origin from the organs of the central and sympathetic systems as cranial, spinal and sympathetic nerves. The nerve fibre which carries the nerve impulses from the receptor to the higher centers like brain and spinal cord are called as sensory or afferent nerve fibres. The nerve fibres which carry the motor response to the effector organ are called motor or efferent

never fibres. The branches of nerves distributed to the muscles are called muscular branches and those supplied to the skin are cutaneous branches and those supplying to the articulations are called as articular branches. Efferent nerves stimulating contraction of muscle are called motor nerves and those stimulating the contraction of walls of the vessels as vasomotor nerves. They are called secretory nerves when they stimulate the glands to secrete. Nerves are called inhibitory nerves when they diminish functional activities of organs. The nerves that control nutrition of the tissues to which they supplied are tropic nerves.

- The tissues or organs that receive the stimuli are called receptors. Receptors are classified according to position and kind of stimuli.
- Based on the position,
    - Exteroceptor – Receptors present on the outer surface of the body that receive different kind of external stimuli.
    - Proprioceptors – Receptors present o the muscles tendon and join.
    - Viseroceptors – Receptors present on the visceral organs.
- Based on the kind of stimuli
    - Mecahanoceptors – Receptors used to received various mechanical stimuli viz pain, pressure etc.
    - Thermoceptors – Receptors used to receive temperature.
    - Baroceptors – Receptors used to receive pressure.
    - Nociceptors – Receptors used to received pain
    - Chemoceptors – Receptors used to receive chemical stimuli.

MENINGES OF BRAIN

- The brain and spinal cord are enclosed by three membranous coverings for their protection known as the meninges.
- They are from without inward the
    - Duramater
    - Arachnoid
    - Piamater

DURAMATER

- This is a dense, tough membrane of white fibrous tissue. It has cranial and spinal parts which enclose the brain and spinal cord, respectively and continuous with each other at the foramen magnum.
- The cranial duramater is not only acting as covering of the brain but also lines the inner surface of the cranium. It is composed of two layers, an outer periosteal layer which is adherent to the internal face of the cranial bones forming the internal periosteum and an inner meningeal layer which is in contact with the arachnoid. It forms the sheath around the nerves and leaving the cranium. These two layers are mostly adherent to each other except at places where they are separated to form the venous sinuses lined by endothelium. The internal surface of the dura is also lined by endothelium and is smooth. It forms the outer boundary of the subdural space that contains a small quantity of fluid resembling lymph.
- The duramater detaches a number of infoldings between the different sections of brain and form the falx cerebri, tentorium cerebelli and a thickening diaphragm sellae or pituitary fold.
- The falx cerebri is a sickle-shaped, vertical fold of duramater situated in the midline between the two cerebral hemispheres. It is attached above to the interparietal and interfrontal crests, behind to the internal occipital protruberance and in front to the crista galli of ethmoid. Its dorsal border is convex and here the two layers of the dura are separate and enclose the dorsal longitudinal sinus. Its ventral border is concave and lies above the corpus callosum. Here again the two layers enclose the ventral longitudinal sinus. Posteriorly it joins the tentorium cerebelli.

- The tentorium cerebelli is a crescentric, transverse fold between the cerebral hemispheres and cerebellum. It is attached above to the internal occipital protuberance and laterally to the petrosal crests. Its ventral border is concave, thin and free and forms an arch over the mid brain.
- The diaphragm sellae is a thick fold of duramater on the ventral aspect of the brain, which surrounds the pituitary gland and encloses the cavernous and intercavernous sinuses. It is perforated at the middle for the infundibulum and laterally for the exit of the emergent artery of the rete mirabile cerebri and the third cranial nerve on either side of the emergent artery.
- The hypophysis cerebri or pitutary gland is an oval reddish grey coloured body about the size of a large pea situated in the sella turicia of sphenoid bone, connected at the base of the brain with a stalk and enclosed by duramater. It consists of two lobes – anterior lobe and posterior lobe. The portion which are developed from the Rathke's pouch are included under the term adenohypophysis. These are
    - pars distalis or pars anterior,
    - pars tuberalis and
    - pars intermedia. These parts constitute the major and important portion of the gland. In other domestic animals and birds no much appreciable difference is observed other than size.
- The spinal duramater starts from the foramen magnum and terminates at the middle of the sacrum. It is composed only of the meningeal layer and forms a very loose tube around the spinal cord. It is separated from the periosteum of the spinal canal by a considerable space called epidural space and is occupied by connective tissue and fat. The dura furnishes sheaths for cranial and spinal nerves.
- The subdural space is the potential space between the dura and arachnoid with small amount of fluid, which moistens the opposed endothelial surfaces.

ARACHNOID MEMBRANE

- It is a very thin, delicate, transparent membrane situated between the dura mater and piamater. The space between the arachnoid and piamater is known as subarachnoid spaceand it is filled with cerebrospinal fluid. The outer face of the arachnoid is lined by endothelium and forms the inner wall of the subdural space. Its internal face is also lined by endothelium and forms outer boundary of the subarachnoid space. The arachnoid furnishes sheaths for nerves only for a short distance. From the internal face of the membrane, several strands of connective tissue arise and join the piamater, thus converting the subarachnoid space into numerous intercommunicating cavities.
- The cerebral part does not dip into the sulci except the great longitudinal and transverse fissures. On the summits of the gyri, it is very closely adherent to the piamater. It bridges over the smaller sulci and here the subarachnoid space is divided into many intercommunicating cavities. In certain places, considerable space is enclosed between it and the piamater and they are the subarachnoid cisterns.
- They are chiefly four in number
    - The cisterna basalis is at the base of the brain and is extended from optic chiasma infront and continued posteriorly into the cisterna pontis.
    - The cisterna fossa lateralis is at the fossa lateralis.
    - The cisterna pontis is extending from the pituitary gland to the pons.
    - The cisterna magna is in the angle between the posterior parts of the inferior face of the cerebellum. It communicates with the fourth ventricle through a central and two lateral microscopic openings and behind with the subarachnoid space of the spinal cord.
- Along the dorsal border of the falx cerebri the arachnoid bears the bulbous excrescences the arachnoid granulations**.** These project into the dorsal longitudinal sinus.
- The spinal arachnoid is continuous with that of the cerebral part and it forms a relatively wide tube around the spinal cord so that the latter with the piamater is surrounded by a considerable quantity of cerebrospinal fluid. The subarachnoid space is traversed by fewer trabeculae than in the cranium. It is partially divided by the dorsal median septum and the two-denticulate ligament of the piamater.
- Cerebrospinal fluid: Tufts of capillaries inside the ventricles are covered by ependyma to form chorioidal plexus. The chorioid plexus of the lateral ventricles mainly forms CSF. CSF thus formed passes to the third ventricle through the interventricular foramen of Monro, it flows from the third

ventricle to fourth ventricle via aqueduct of Sylvius. From fourth ventricle a small amount of fluid passes through the central canal of spinal cord and the major portion escapes to the subarachnoid space through the foramina Megendie and Luschka. The foramina Luschka are the two laterally placed apertures and foramen Megendie is the centrally placed aperture at the root of the fourth ventricle. The fluid is drained into the venous system mainly through arachnoid granulations.

PIAMATER

- It is a very delicate vascular membrane that closely invests the brain and the spinal cord and sends processes into the brain substance.
- The cerebral piamater accurately moulds itself on the brain by dipping itself into all the sulci and fissures. Its external face forms the inner boundary of the subarachnoid spaceand is lined by endothelium. From its deep face trabeculae are given off which dip into the substance of the brain. The smaller blood vessels ramify in the piamater forming plexuses.
- Folds of piamater extend into two of the fissures of the brain. One of these is the telachorioidea of the third ventricle that enters the transverse fissure and forms the roof of the third ventricle. Another fold passes into the space between the cerebellum and medulla and forms the telachorioidea of the fourth ventricle.
- The spinal piamater is thicker and denser. It sends a fold into the ventral median fissure of the spinal cord and also helps to form the dorsal median septum. Along the mid ventral line it forms a thickening the linea splendens in which runs the ventral spinal artery. On each side it gives off a strong longitudinal band, the denticulate ligament lying between the dorsal and ventral roots of the spinal nerves.

BRAIN

- The brain is that part of the central nervous system which is situated in the cranial cavity. Its average weight is about 500 grams in the ox, 1.5 kg. in man, 750 grams in horse and 60 grams in dog.
- When the brain is seen from above, the parts that are visible are cerebral hemispheres, cerebellum and part of medulla oblongata.
- The cerebral hemispheres are oval and are separated by the great longitudinal fissure. The falx cerebri dips in this fissure. The surfaces of the hemispheres are marked by a number of winding ridges-the cerebral gyri or convolutions separated by sulci. The upturned projections are seen at the anterior extremity in front of the frontal pole called the olfactory bulbs. The occipital pole covers the mid-brain and overlies on each side, the anterior part of the cerebellum from which it is separated by the great transverse fissure which contains the tentorium cerebelli. (View image)
- The cerebellum is much smaller and conceals greater part of the medulla. Its surface shows a number of minute gyri and sulci.
- The ventral surface or the base of the brain presents the following features from behind forward
    - The median brain stem is continuous with the spinal cord behind and it consists of three parts,
        - Medulla oblongata- the posterior part which extends forward as the direct continuation of the spinal cord.
        - The pons- a transversely elongated mass which appears infront of the medulla oblongata.
        - The cerebral peduncles or crura cerebri which extend from under the pons forward and diverge to enclose the interpenduncular fossa.
    - The interpeduncular fossa is largely covered by the pituitary gland and connected to the base of the brain by a hollow tube of gray mater the infundibulum which in turn is attached to a gray body the tuber cinerium. Behind this is a white body called the mamillary body or corpus albicans. The posterior part of this space is perforated for the passage of fine blood vessels to the thalamus.
    - A band of white mater the optic tract crosses the anterior end of each cerebral peduncle and unites with its fellow and crosses to form the optic commissure or optic chiasma. This forms the anterior boundary of the interpenduncular fossa. Above and in front of the chiasma is the great longitudinal fissure.

CRANIAL NERVES

- There are twelve pairs of cranial nerves.
    - The first pair or olfactory nerve joins the convex ventral face of the olfactory bulbs.
    - The second pair or optic nerve arises from the lateral geniculate bodies; the optic tracts converge to the optic chiasma and are then continued as optic nerves.
    - The third pair or oculomotor nerve arises from the ventral face of the cerebral peduncle at the interpenduncular fossa.
    - The fourth pair or trochlear nerve arises from the dorsal aspect behind the posterior colliculus of midbrain, pass outwards and emerge between the pons and the cerebral hemispheres.
    - The fifth pair or trigeminal nerve is connected to the lateral part of the pons by a large sensory and a small motor root.
    - The sixth pair or abducent nerve arises behind the pons lateral to the anterior ends of pyramids of the medulla.
    - The seventh pair or facial nerve and the eighth or auditory nerve arise close together from the lateral part of corpus trapezoideum.
    - The ninth pair or glossopharyngeal nerve
    - Tenth and eleventh- vagus nerve and spinal accessory nerve arise in a series from the lateral aspect of the medulla behind the seventh. The spinal accessory nerve has two roots-a medullary and a spinal. A spinal root arises from the first five cervical segments of spinal cord and joins with the medullary root of spinal accessory nerve.
    - The twelfth pair or hypoglossal nerve arises lateral to the posterior part of the pyramids of the medulla.
- The brain is anatomically may be divided into cerebrum, cerebellum,pons, and medulla oblongata.For description five divisions may be considered.These are cerebral hemispheres,inter brain,mid brain,hind brain and medulla oblongata.

MODULE-14: FOREBRAIN

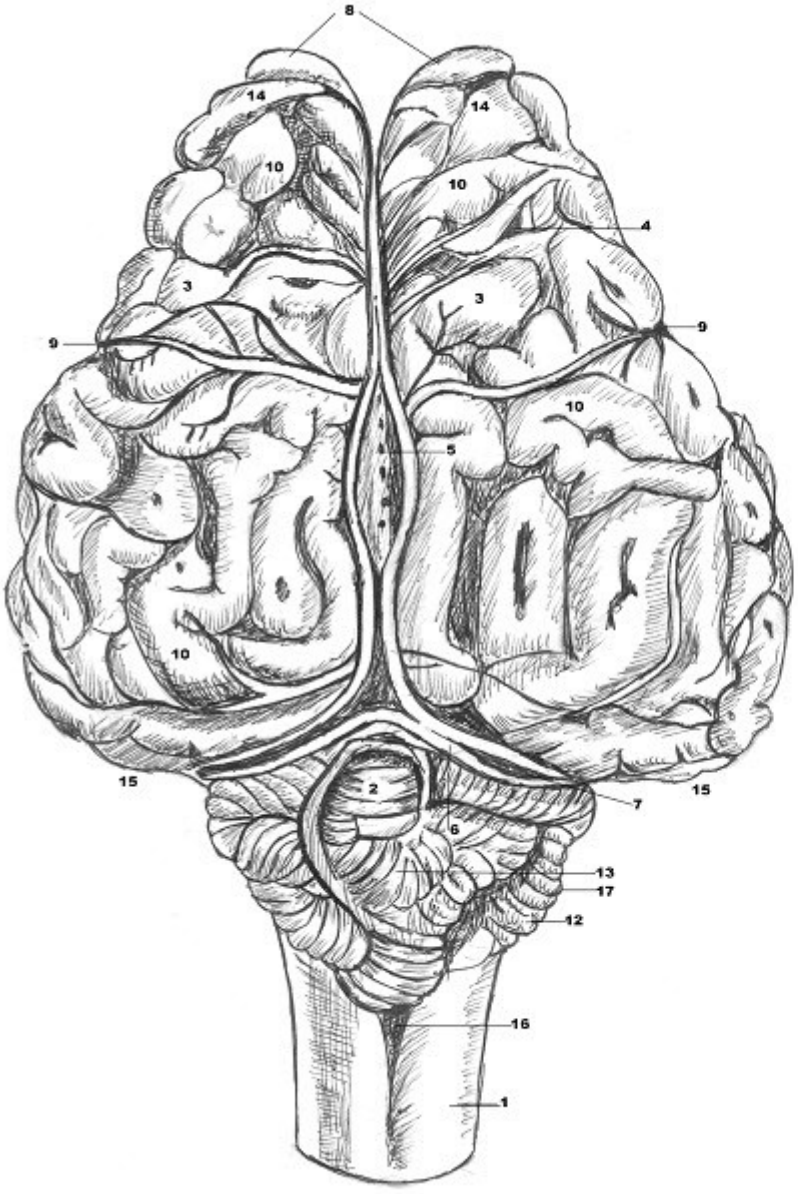
LEARNING OBJECTIVES

- You will learn about the detail structure of cerebral hemispheres, rhinencephala, olfactory part of brain, thalamic body and hypothalamus.
- To study about basal ganglia and four important nuclei.
- To study about pineal body or epiphysis cerebri, hippocampus etc.
- It helps to understand the hypophyseal portal system and its circulation.

CEREBRAL HEMISPHERES

- Each cerebral hemisphere consists of

- Cerebral cortex
- Basal ganglia or corpus striatum, masses of gray mater embedded within the hemisphere and not visible superficially
- The rhinencephalon or olfactory part of the brain in the lower part of hemisphere, portions of which can be seen on the ventral surface are olfactory bulb, striae, trigonum olfactorium and piriform lobe.



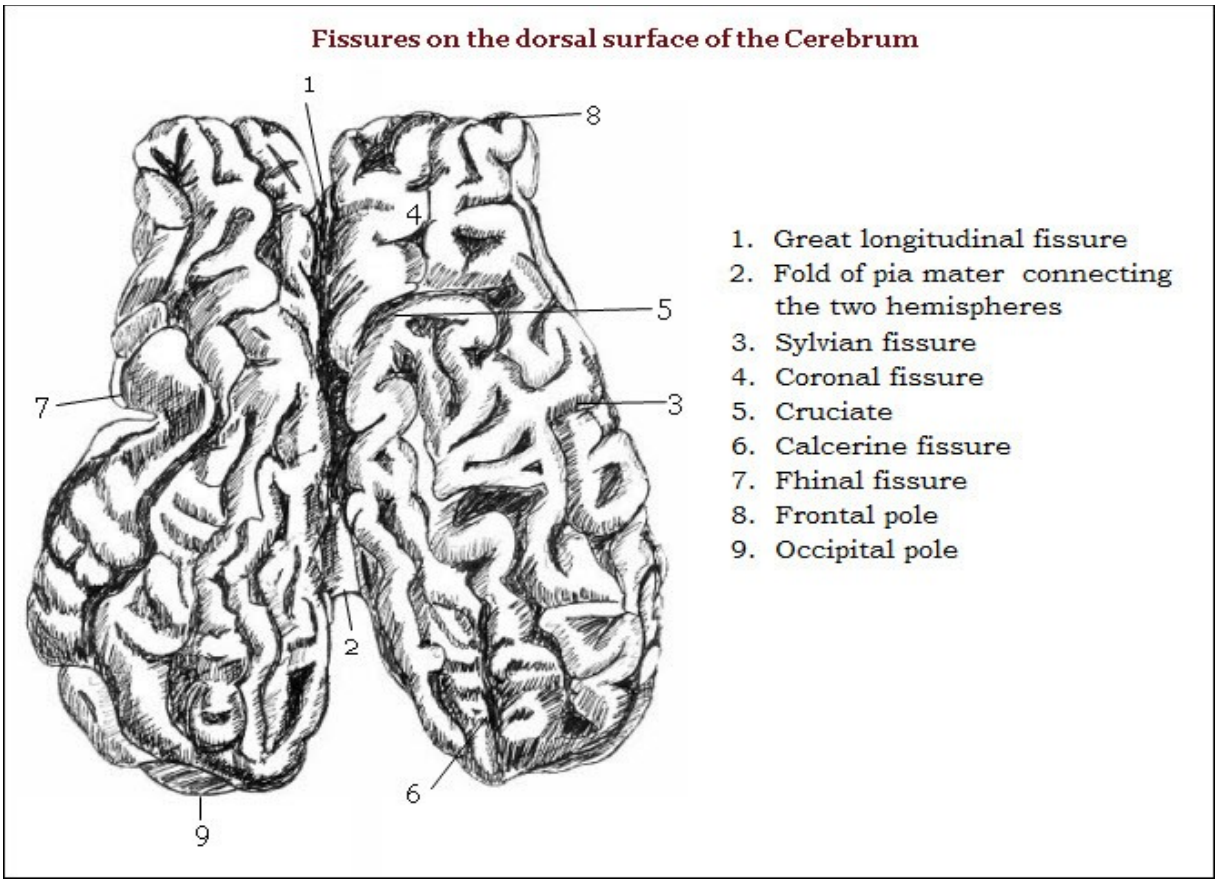
Dorsal view of the brain

1. Medulla oblongata
2. Cerebellum
3. Cerebral hemispheres
4. Cerebral sulci
5. Dorsal longitudinal sinus
6. Tentorium cerebelli
7. Transverse sinus
8. Olfactory bulb
9. Position of Sylvian fissure
10. Creebral gyri
11. Crebral sulci
12. Cerebellar gyri
13. Vermis of cerebellum
14. Frontal poles
15. Occipital poles
16. Dorsal median fissure of medulla o
17. Lateral lobes of cerebellum

CEREBRAL CORTEX

- The cerebral cortex is made up of numerous *convolutions* or *gyri* and is separated by the *sulci*.

- The great longitudinal fissure, which lodges the falx cerebri, divides the cerebrum into two equal halves completely.
- Centrally the fissure extends up to the corpus callosum. The corpus callosum is the connection between the two hemispheres at the median line. Beside the sulci, there are some longer depressions on the hemispheres. They are known as fissures. The fissures are as follows,
    - The *coronal fissure* is deep and is directed upward and medially over the frontal pole. It continues backward towards the medial border of the hemisphere where it ends.
    - The *crucial fissure* begins a little behind the middle of the great longitudinal fissure and passes across.
    - The *rhinal fissure* is a distinct furrow on the lower part of the lateral face of the hemisphere and it extends antero-posteriorly. This fissure separates the rhinencephalon below from the cerebral cortex or neopallium above.
    - The *Sylvius fissure* is on the lateral aspect, at the level of the fossa lateralis and lodges the middle cerebral artery. It passes vertically upwards for a short distance.
    - The *callossal fissure* is on the medial face and separates the corpus callosum from the gyrus fornicatus.
    - The *calloso - marginal fissure* is extensive and well defined and is on the medial face of the hemisphere. It lies parallel to the dorso-medial borders of the corpus callosum and curves like a "C" to the posterior part of the hemisphere. The posterior part of this fissure is the *anterior calcarine fissure* that shows a sulcus going upward and backward into the tentorial surface of the hemisphere and corresponds to the *posterior calcarine fissure* of man. (Click here to recollect the different Fissures in Dorsal view of brain)



CORTICAL CENTRES OF BRAIN

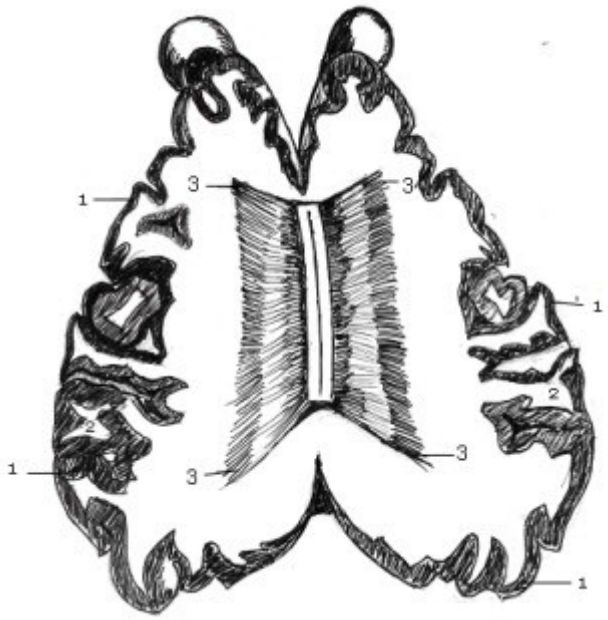
- In each hemisphere, the cortical areas have been identified depending on their action. They are
    - The motor area is the anterior and posterior sigmoid gyri which wind round the crucial fissure as their axis.
    - Coronal gyrus contains the somaesthetic area and is located below and lateral to the coronal sulcus.
    - The postsylvian gyrus contains the auditory area that is between the middle and posterior branches of the sylvian fissure.
    - The lingual gyrus containing the visual area is on the tentorial face of the cerebral hemisphere between the anterior and posterior calcarine fissure.
    - The gyrus fornicatus is double and lies on the medial face of the hemisphere between the callosal and calloso-marginal fissure. In this gyrus the area for taste is located in its upper part and the area for smell is located in its lower part which is continuous with the hippocampal gyrus.

- When the upper part of the cerebral hemisphere is sliced away gradually upto the cingular gyrus, it will be noted that in each hemisphere, there is a peripheral layer of gray mater and a central mass of white mater. When the two hemispheres are gently pulled apart a mass of white mater can be seen below the level of callosal fissure extending from one hemisphere to another. This is the corpus callosum that becomes fully exposed on removing gray mater on the lateral aspects of the corpus callosum.
- The gray mater is the outer layer of the cerebral mass and is composed of nerve cells.
- The white mater is composed of medullated nerve fibres supported by neuroglia. These are
    - *Commissural fibres:* corpus callosum, anterior and posterior commissures that connect the two cerebral hemispheres.
    - *Association fibres:* Short or long, connect different parts of the cortical substance in each hemisphere. E.g., cingulum superior, longitudinal fasciculus, inferior longitudinal fasciculus, uncinate fasciculus and fronto-occipital fasciculus.
    - *Projection fibres:* connecting the cerebral cortex with the medulla and spinal cord, E.g., fibres of the internal capsule.
- Due to lack of pores and tight junctions in the wall of the capillaries of the central nervous system, diffusion of materials to the parenchyma is either stopped or restricted. This so called obstruction between the blood and CNS parenchyma is known as blood- brain barrier.

CORPUS CALLOSUM

- It is the largest mass of commissural fibres that connect the two cerebral hemispheres.
- The fibres spread out laterally in a radiating manner in the central white mater of each hemisphere.
- These fibres are crossed by the ascending fibres of the internal capsule.
- The central part or truncus between the two hemispheres appears as arched structure, sloping downwards and forwards and curving downwards at the anterior and posterior ends.
- The anterior end or genu bends downwards and backwards and thins out to form the rostrum which is continuous with the lamina terminalis closing the anterior part of the third ventricle.
- The posterior end or splenium lies at a higher level than the genu.
- The dorsal surface of the corpus callosum is convex. It is covered dorsally by a thin layer of gray mater indusium griseum and shows two longitudinal striae -medial and lateral on each side of median line.
- The indusium griseum and the longitudinal striae are the ill developed parts of the rhinencephalon. The ventral face is concave and forms the roof of the lateral ventricles and the septum lucidum attached to it medially.
- The septum lucidum is the median partition between the two lateral ventricles.
- Its dorsal border is convex and is attached to the corpus callosum and the concave ventral border is attached to the fornix.
- Its anterior part is received into the genu and it becomes narrow behind at the splenium.

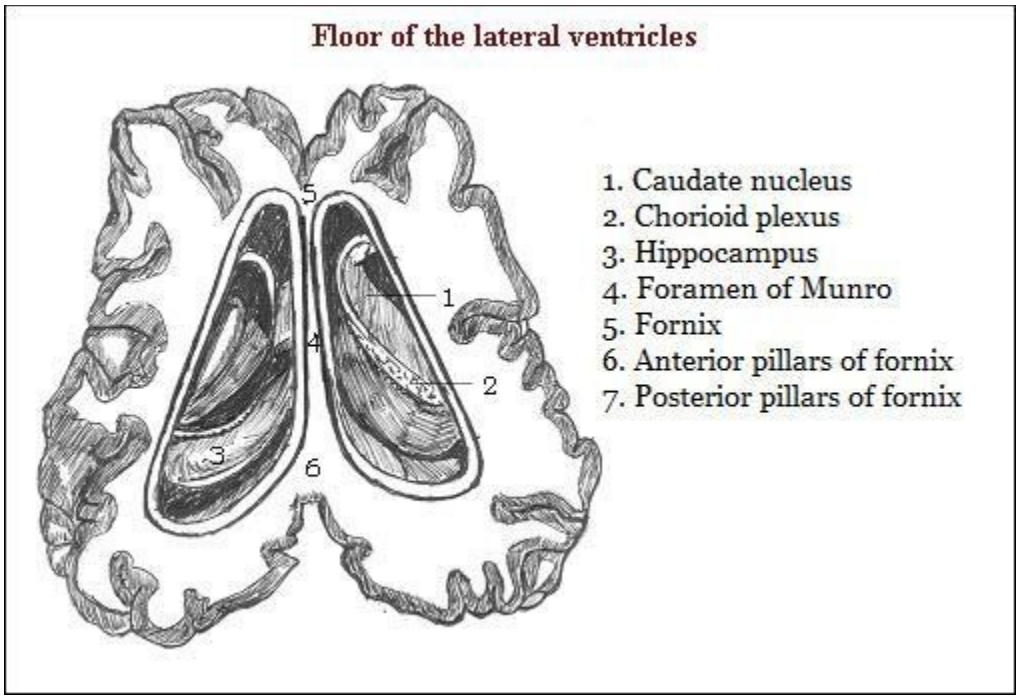
Cerebral hemisphere sliced to show the corpus callosum



1. Gray matter
2. White matter
3. Corpus callosum

HIPPOCAMPUS

- This is an invagination of the cerebral cortex at the lateral ventricle through the hippocampal sulcus. This gyrus curves from the deep face of the piriform lobe around the thalamus and forms the posterior part of the floor of the lateral ventricle.
- By careful blunt dissection along the posterior horn of the lateral ventricle into the piriform lobe, the hippocampus on each side can be easily separated and raised.
- On the ventral or deep face of the hippocampal gyrus a narrower band the dentate gyrus can be seen and laterally the two gyri separated by the hippocampal fissure.
- The dorsal or ventricular surface of the hippocampus is covered with white mater called the alveus derived from hippocampal and dentate gyri, which converge on the lateral margin to form a band of white mater called the fimbria which on either side continues forwards as the posterior pillars of fornix.
- The two hippocampi are connected to each other at their upper parts by the hippocampal commissure.
- The hippocampus represents an olfactory centre of higher order receiving fibres from the piriform lobe and its efferent fibres the fimbria and fornix reach the mammillary body.



RHINENCEPHALON

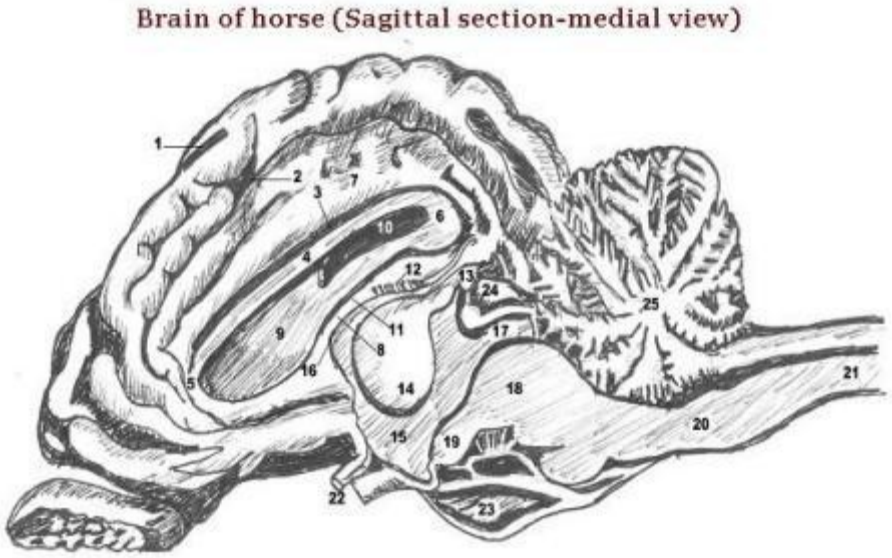
Olfactory bulbs

- These are oval elongated structures in each hemisphere, situated at the anteroventral aspect of the frontal pole and are lodged in the olfactory fossae.
- Each bulb receives olfactory nerves coming from the nasal mucosa through the olfactory perforations of the cribriform plate of the ethmoid bone.
- The olfactory tract is a thick and short bundle of fibres that extends back wards and divides into medial and lateral olfactory stria.
- The trigonum olfactorium is a triangular area placed between the two stria.
- The lateral stria is longer and passes backward and outward along the medial aspect of rhinal sulcus and enters the inferior part of the hippocampal involutions.
- The inner one passes backward and inward to the internal aspect of the cerebral hemisphere.

INTERBRAIN - THALAMUS

- It is a large ovoid mass of gray mater situated obliquely across the dorsal face of cerebral peduncles, so that the two bodies meet in front at a right angle.
- Medially they are fused to large extent and around this area of adhesion is an annular space called the third ventricle.
- The dorsal face of the thalamus is convex and is separated from the overlying hippocampus by the tela chorioidea. Laterally it is separated from the caudate nucleus by a band of white mater called the stria semicircularis.
- The posterior part of the thalamus is in the form of a rounded ridge continues laterally with the optic tract called the lateral geniculate body which is blended with it. Behind the point of emergence of the optic tract, in the angle between the thalamus and the cerebral peduncle is the medial geniculate body.
- Thalamus receives all afferents from medial lemniscus (proprioceptive and tactile), spinal lemniscus (pain and temperature), trigeminal lemniscus (all exteroceptive sensations from the trigeminal area) and mammillo-thalamic (olfactory) tracts.

- The lateral and medial geniculate bodies receive the visual and auditory impulses respectively. All these are correlated and integrated and are then relayed to the respective cortical areas.



1.Cerebral cortex, 2.Cerebellum, 3.Olfactory bulb, 4.Calloso-mariginal fissure, 5.Callosal fissure, 6.Anterior calcarine fissure, 7.Posterior calcarine fissure, 8.Lingual gyrus (visual area), 9.Singular gyrus (olfactory area), 10.Upper part of gyrus fornicatus (gustatory area), 11.Corpus callosum, 12.Genu, 13.Splenium, 14.Lateral ventricle, 15.Fornix, 16.Thalamus, 17.Third ventricle, 18.Pineal gland, 19.Anterior calliculus, 20.Posterior caooliculus, 19&20. Corpora quadrigemina, 21.Anterior commissure, 22.Optic chiasma, 23.Pituitary, 24.Mamillary body, 25.Cerebral peduncle, 26.Pons, 27.cerebral aqueduct, 28.Fourth ventricle, 29.Medulla oblongata, 30.Spinal cord, 31.Corpus medullare, 32.Anterior medullary velum, 33.Posterior medullary velum.

PINEAL GLAND AND HYPOTHALAMUS

Pineal gland

- It is a small ovoid or fusiform gland situated dorsally in a deep depression between the thalami and the corpora quadrigemina.
- It is attached to the postero-superior quadrant of the third ventricle by a hollow stalk, which is a small recess of the third ventricle.
- Immediately under the posterior part of the stalk is a short transverse band of white mater called the posterior commissure.

Hypothalamus

- The term hypothalamus does not refer to any single structure anatomically.
- It includes the wall of the third ventricle below the thalamus, optic chiasma, tuber cinerium, infundibulum, mamillary body, subthalamic nuclei, posterior perforated substance etc.
- The hypothalamus is functionally important as it contains centres of the sympathetic and parasympathetic systems regulating visceral activities; centres for regulation of body temperature, fat, carbohydrate and water metabolism, centre for sleep rhythm etc.

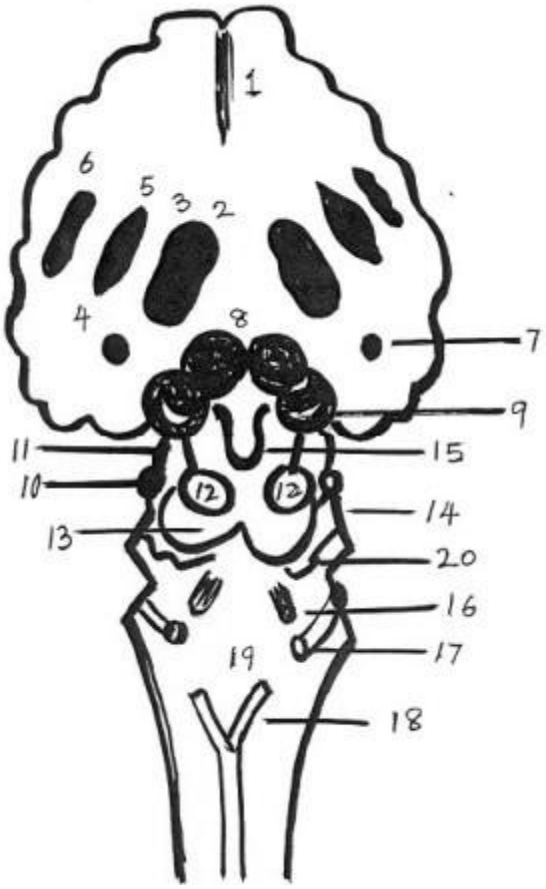
- Neurons in the hypothalamus are also concerned in the regulation of secretion of hormones in the pars anterior of the pituitary through secretion of chemical mediators or releasing factors into the blood stream (Hypophyseal portal circulation).
- In addition, other neurons in the hypothalamus are responsible for secretion of the posterior pituitary hormones which are conveyed by the axons of these neurons through the hypothalamo-hypophyseal tract to the pars nervosa, where they are released in to the blood stream. Click to see the functional areas of hypothalamus

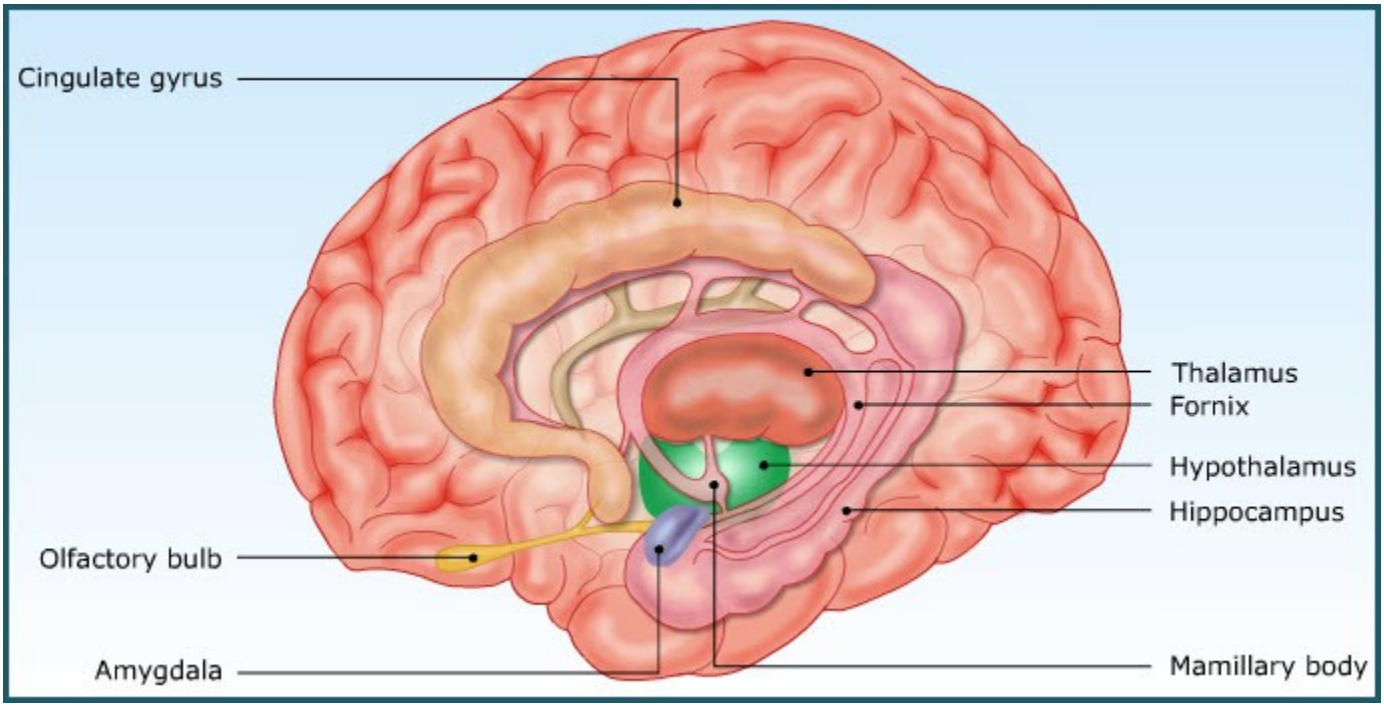
FORNIX

- It is composed of longitudinal white fibres that arch over the thalamus and the third ventricle.
- It consists of a body and two pairs of pillars, anterior and posterior.
- The body is formed by the fusion of the two arches by which the fornix is composed.
- It is triangular and overlies the anterior part of the thalami and the third ventricle.
- The dorsal surface blends with the septum lucidum and on either side, it forms the floor of the lateral ventricle.
- The lateral border is related to the chorioid plexuses and forms the internal boundary of the interventricular foramen.
- The anterior pillars are two slender bundles which emerge from the body and diverge slightly as they curve ventrally and backward to enter the mammillay body and they are crossed in front by the anterior commissure.
- The posterior pillars are much larger bands that are the forward continuations of the fimbria from each side, which unite to form the body.

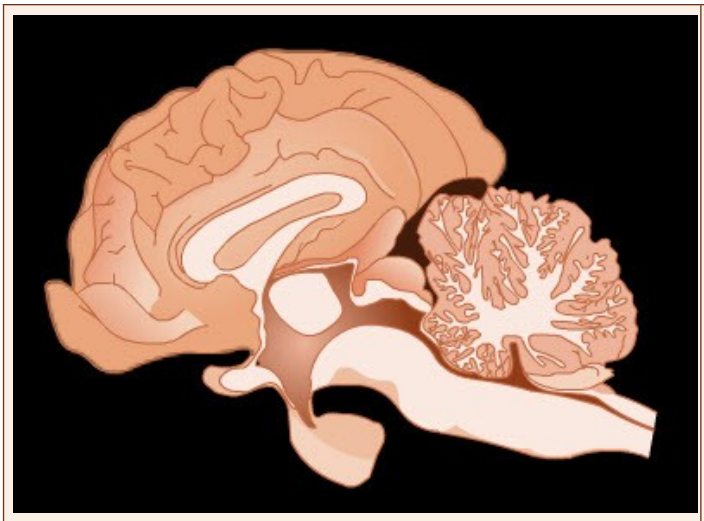
BASAL GANGLIA OR CORPUS STRIATUM

- The basal ganglia consists of masses of gray mater or nuclei, viz. the caudate and lenticular nuclei, claustrum and amygdaloid within the cerebral hemisphere. The caudate and lenticular nuclei are incompletely separated by tracts of white mater called the internal capsule . The internal capsule actually consists of a masses of projection fibres connecting cerebral cortex with lower levels of brain and spinal cord.
- The caudate nuclei lies medially and its head forms the anterior part of the floor of the lateral ventricle and becomes continuous with the amygdaloid nucleus. The lenticular nucleus is shaped like a biconvex lens and medially it is separated from the caudate nucleus by the internal capsule and laterally covered by a thin band of white mater called the external capsule that separates it from a thin band of gray mater, claustrum that is dentated laterally. The lenticular nucleus is subdivided into an external part, the putamen and an internal part the globus pellidus.
- The amygdaloid nucleus is a small ovoid mass of gray mater situated lateral to the posterior cornu of the lateral ventricle and is believed to be a correlation centre for olfactory and somatic sensibilities.
- The basal ganglia is an important motor correlation centre in lower vertebrates and forms an important part of the extra-pyramidal system, through its connections to substantia nigra and red nucleus . It also plays part in regulating tonus of voluntary musculature by modifying the activities of the lower motor neurons and also control automatic associated movements.





MODULE-15: MIDBRAIN



LEARNING OBJECTIVES

- This topic describes on the structure of corpara quodrlgemina, cerebral acqueduct and the cerebral peduncles.
- To study about Substantia nigra and red nucleus.
- It will help understanding the cell station in midbrain and signaling pathways, reflex pathways etc.

CORPORA QUADRIGEMINA

- These are four rounded eminences, which form the upper part of the midbrain and lie under posterior part of the cerebral hemispheres.
- They consist of two parts of colliculi (anterior and posterior) separated by a transverse groove.
- The anterior colliculi are larger and placed higher in level than the posterior and are known as nates.
- They are gray in colour, hemispherical and separated by a shallow furrow.
- A wide groove intervenes between them and thalami. The posterior colliculi are smaller and paler called the testes.
- They are limited behind by a transverse furrow on either side from which emerges the fourth pair of nerves.
- The anterior colliculi are connected by an indistinct band of fibres called the superior brachium to the lateral geniculate body.
- The posterior colliculi are connected to the medial geniculate body by a band of white fibres called the inferior brachium.
- The posterior colliculi also receive the lateral lemniscus or fillet seen laterally as a rounded narrow band passing upward and forward from under the pons.
- The anterior colliculi are visuo-spinal reflex centres concerned with movements of musculature of eyes, head, neck, and also of the limbs necessitated by visual impulses. It receives visual impulses from the optic tract through the superior brachium; its efferent fibres form the tecto-spinal tract.
- The posterior colliculi are audito-spinal reflex centres concerned with similar reflexes in response to auditory impulses conveyed to them by the lateral lemniscus. Efferent fibres form the tecto-spinal tract.

CEREBRAL AQUEDUCT

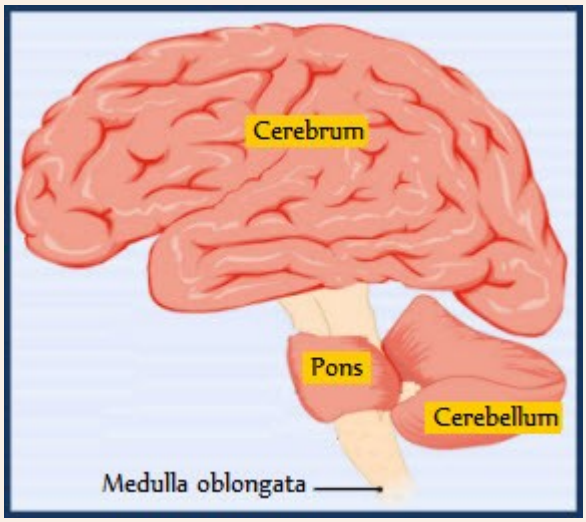
- The cerebral aqueduct or aqueduct of Sylvius is a narrow passage through the mesencephalon and connects the third and fourth ventricles.
- It is situated at the median plane.
- The shape of the lumen is variable at different places. It is lined by ciliated columnar epithelium.
- Surrounding it is a layer of gray mater which is continuous anteriorly with the third ventricle and posteriorly with the gray mater of the fourth ventricle. This gray mater accommodates the nuclei of the third, fourth and fifth cranial nerves.

CEREBRAL PEDUNCLES OR CRURA CEREBRI

- These are two broad bundles situated at the lower part of the midbrain and appear on the ventral face of the brain as two columns that emerge from under the pons and diverge forward to enter the cerebrum. At the point of disappearance, the optic tract winds obliquely across the peduncle.
- These contain the descending and ascending tracts of the spinal cord. Each peduncle consists of a dorsal part tegmentum, middle part the substantia nigra and the ventral part the crus cerebri.
- The crus cerebri consists of cortico-spinal, cortico-nuclear and cortico-pontine fibres. Substantia nigra is a layer of gray mater and composed of numerous deeply pigmented nerve cells and forming part of the extra-pyramidal system.
- At the dorsomedial aspect of each substantia nigra, an ovoid mass of nerve cells with pinkish tinge is seen.
- This is called as the red nucleus, which forms an important cell station in the extra pyramidal system and gives rise to the rubrospinal tract.
- The tegmentum is continuous with the pons and contains some fibre tracts.

- The inter penduncular fossa is a space formed between the cerebral peduncles optic tracts and chiasma.
- It accommodates a hollow tubercle known as tuber cinerium and small nodule like structure situated behind the tuber called mammillary body or corpus albicans.
- Dorsally the tuber cinerium is connected with the third ventricle and ventrally with a conical tube the infundibulum.
- The infundibulum is attached to the pituitary gland.

MODULE-16: HINDBRAIN



LEARNING OBJECTIVES

- To study the components of hindbrain - cerebellum, Pons and medulla oblangata.
- To study the cerebellar peduncles and its attachments.
- It will help to understand the function of cortico- panto - cerenellar pathway and contol of equilibrium.

CEREBELLUM

- The cerebellum or lesser brain is separated from the cerebral hemispheres by the great transverse fissure.
- It overlies the pons and greater part of the medulla oblongata and the fourth ventricle. It is globular in shape and compressed dorso-ventrally.
- The surface of the cerebellum is cut into gyri by narrow but deep sulci into which the piamater dips.
- The anterior surface faces dorsally and forwards and is covered by the tentorium cerebelli.
- The cerebellum is connected by three pairs of peduncles with the medulla, pons and midbrain. The cerebellar peduncles are three on each side; join the central white substance of the cerebellum called the corpus medullare at its base. The posterior peduncle is the restiform body of the medulla.

- The middle peduncle or brachium pontis is formed by the continuation of the lateral parts of the pons. The anterior peduncle or brachium conjunctivum passes forwards on either side on the dorsal face of the pons forming the lateral boundaries of the fourth ventricle.
- These two peduncles disappear under the corpora quadrigemina into mid brain.
- The cerebellum is divided into three lobes, a median vermis and two lateral hemispheres.
- The vermis is curved in a circular manner so that its two extremities are close together or even in contact with each other on the ventral face.
- The anterior extremity gives attachment to the anterior medullary velum or valve of Vieussens. Similarly another thin lamina, which connects the posterior extremity to the medulla oblongata called the posterior medullary velum.

- The hemispheres are separated by two vela that form the roof of the fourth ventricle.
- The hemispheres are separated by two fissures from the vermis and present the flocculus ventrolaterally.
- On sagittal section, the cerebellum consists of gray cortex outside and white substance internally.
- The latter consists of a central mass, the corpus medullare that joined by the peduncles.
- Corpus medullare gives off primary branches to the lobules. From these, secondary and tertiary laminae arise and the entire arrangement is spoken as arbor vitae.
- The central gray substance consists of four groups of nerve cells which are embedded in the central white mater the nucleus dentatus, nucleus embolifomis, nucleus globosus and nucleus fastigii.
- The cerebellum is concerned with control of equilibrium and the synergistic control of skeletal muscles involved in complex movement. View the animation

PONS

- The pons is located between the medulla oblongata and the cerebral peduncles.
- It is marked off from these ventrally by the anterior and the posterior transverse grooves. When viewed ventrally it is elongated, convex in both directions and presents a median groove, which lodges the basilar artery.

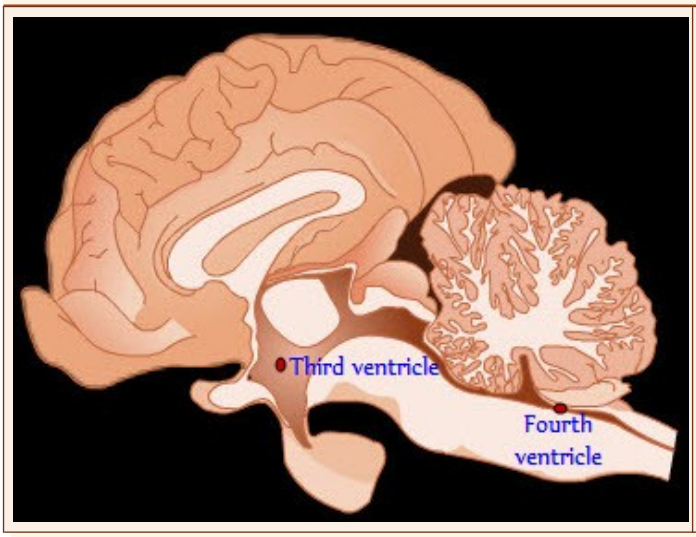
- Laterally a large part of it curves dorsally and backward into the base of the cerebellum forming the middle cerebellar peduncle.
- The dorsal surface is blended on each side with the overlying anterior cerebellar peduncle. The central free *part* forms the anterior part of the floor of the fourth ventricle.
- Pons contains nuclei, which form the cell stations in the cortico-pontocerebellar pathway, which effects coordination between the motor cortex and cerebellum.

MEDULLA OBLONGATA

- It is the cranial continuation of the spinal cord and extends from the foramen magnum to the posterior margin of the pons. This is a quadrilateral structure wider in front than behind and compressed dorsoventrally.
- Its inferior surface is convex transversely and presents median fissure, which ends in front in a small depression called the foramen caecum and posteriorly it terminates in the central part of a transverse band called the corpus trapezoideum. On either side of medium fissure is a rounded prominence known as inferior pyramids, which pass under the pons in front and disappear gradually behind.
- The corpus trapezoideum is transverse band that lies behind the pons.
- The dorsal surface of medulla oblongata is largely concealed by the cerebellum and forms the greater part of floor of the fourth ventricle. The dorsal median fissure of spinal cord extends to about the middle of the medulla. Here the restiform bodies which constitute the lips of the fissure and diverge to form the lateral boundaries of the posterior part of the fourth ventricle.
- The dorsolateral groove of the spinal cord winds outward and forward to the lateral aspect where it presents the roots of the ninth, tenth and eleventh cranial nerves. The central canal of the spinal cord continues in the posterior part of the medulla and opens into the posterior angle of the fourth ventricle.

- The chorioid plexuses of the fourth ventricle occupy the recess between the medulla oblongata and the cerebellum.
- The medulla oblongata contains ascending and descending fibres and also motor and sensory nuclei of the fifth to the twelfth cranial nerves.

MODULE-17: VENTRICLES OF BRAIN



LEARNING OBJECTIVES

- You will learn about the lateral ventricles, third ventricle and fourth ventricle enclosed within the brain.
- To study the boundaries of ventricles and communication between the ventricles.
- To study about the fornix and choroid plexus.

LATERAL VENTRICLES

- They are right and left and each is an irregular cavity in the interior of each cerebral hemisphere communicating with each other and with the third ventricle by the foramen of Munro. Each ventricle has three parts, body and two cornua or horns.
- The body extends backwards to the splenium and communicates with the third ventricle through the interventricular foramen of Munro situated below the fornix and between it and the thalamus. The anterior cornua is in front and it communicates with the cavity of the olfactory bulb. The posterior cornua curves downward and forward into piriform lobe. Each lateral ventricle has a roof, floor and a medial wall. The roof is formed by the corpus callosum and the medial wall is by the posterior part of the septum lucidum. The floor is formed by the two chief nuclei-caudate nucleus in front and the hippocampus behind and the body of the fornix medially and in front.
- The caudate nucleus is a pear shaped body, the long axis of which is directed upward backward and outward. Hippocampus is white on its ventricular face, curves outward downward and then forward to join the piriform lobe. These two bodies are separated by an oblique groove that is occupied by the choroid plexus of the lateral ventricle. On drawing the chorioid plexus aside, along the margin of the caudate nucleus, a narrow band of the white mater called the stria terminalis (taenia semicircularis) is seen.

THIRD VENTRICLE

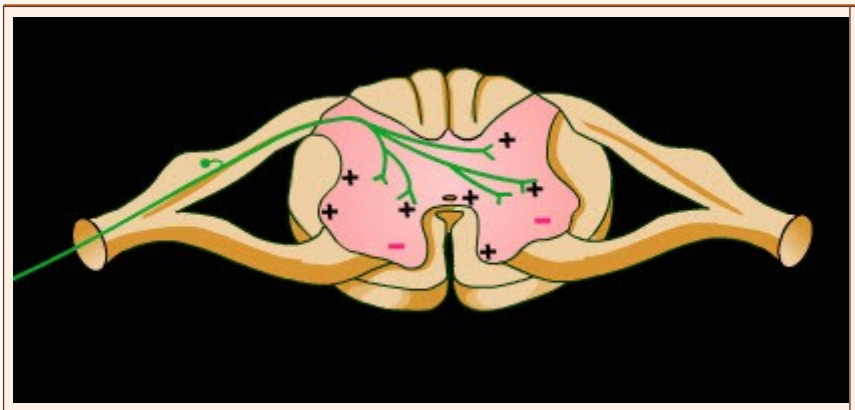
- It is the narrow annular space around the fused medial faces of the two thalami.
- It communicates in front with the lateral ventricles through the interventricular foramen of Munro and behind with the fourth ventricle through the cerebral aqueduct.
- The floor of the ventricle is formed by the structures of the interpenduncular fossa.
- The roof is formed by the telachorioidea and fornix.
- The anterior wall is a thin layer of gray mater stretching from the superior face, of the optic chiasma to the rostrum of the corpus callosum.

- The cavity of the third ventricle presents three recesses the optic recess into the optic chiasma, pineal recess into the stalk of pineal body, the infundibular recess in the infundibulum or stalk of the pituitary gland. (Click here to view the image)

FOURTH VENTRICLE

- The fourth ventricle or rhomboid fossa is the cavity of the hindbrain. It communicates behind with the central canal of the spinal cord and in front with the third ventricle through the cerebral aqueduct.
- The floor is formed by the medulla and the pons. The posterior part narrows to a point at its communication with the central canal and this part is termed the calamus scriptorius.
- The lateral wall is formed by the restiform body and anterior cerebellar peduncles.
- The roof is formed by the vermis and the anterior and posterior medullary vela.
- The fourth ventricle communicates, with the cisterna magna by a central and two lateral microscopic foramina Megendie, Key and Retzius respectively in the posterior medullary velum.

MODULE-18: SPINAL CORD



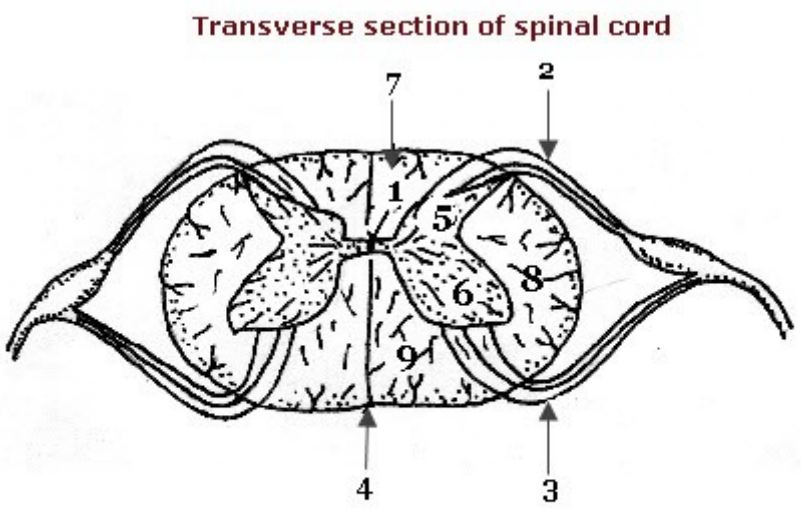
LEARNING OBJECTIVES

- To study the formation and arrangement of spinal cord and the nerves arising from it.
- To study the detail of grey matter and white matter of spinal cord.
- To have a better understanding on the tracts of spinal cord and their function.

STRUCTURE OF SPINAL CORD

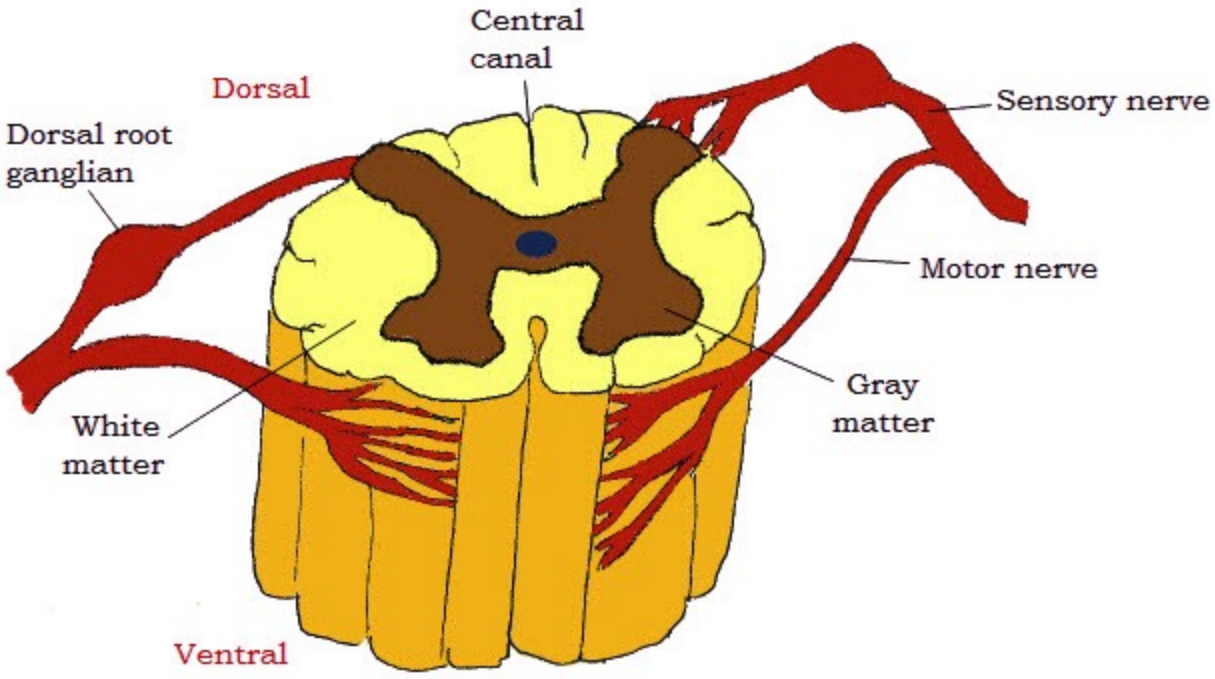
- The spinal cord is that part of the central nervous system situated in the vertebral canal. It extends from the foramen magnum to about the middle of the sacrum. It is approximately cylindrical and more or less compressed from above downward. It is continuous with the medulla oblongata at the foramen magnum, where there is no natural line of demarcation. Its terminal part rapidly narrows to a point called the conus medullaris. This is prolonged for a short distance by a slender filament of piamater called filum terminale.
- As a result of the unequal growth of the nervous tissue and the vertebral column, correspondence between the two is not exact and the spinal nerves usually have to travel a short distance backward before they gain exit from the canal. The conus medullaris reaches only the anterior part of the sacral canal and hence the rest of the sacral canal is occupied by the sacral and coccygeal nerves extending backward in the canal for a considerable distance before they pass out of it, forming a sort of a bundle

in the middle of which is the conus medullaris and filum terminale. This arrangement is termed as the cauda equina.



1. Central canal 2. Dorsal root fibre 3. Ventral root fibre 4. Ventral median fissure 5. Dorsal horn 6. Ventral horn 7. Dorsal funiculus 8. Lateral funiculus 9. Ventral funiculus

- The spinal cord is fairly uniform in the greater part of the thoracic region but there are two conspicuous enlargements that involve segments with which the nerves of the limbs are connected. The cervical enlargement begins about the fifth cervical segment and subsides at the second thoracic and the lumbar enlargement is at about the fifth lumbar, beyond which the cord rapidly narrows to form the conus medullaris.
- The surface of the cord is divided into two equal halves by a dorsal median groove and a ventral median fissure. On either side of the former is a dorso-lateral groove where the dorsal root fibres of spinal nerves enter the cord. The ventral root fibres leave the cord a little lateral to the ventral median fissure. The dorsal median groove is filled up by the dorsal median septum and the ventral one is narrow and deep and reaches to about the middle of the cord. The two halves of the cord are connected by commissures of gray and white mater. The gray commissure is a transverse band at the base of the dorsal median septum and is traversed by the central canal of the spinal cord. The white commissure is a bridge of white mater that connects the two ventral columns of white mater.
- The central canal opens anteriorly into the posterior angle of the fourth ventricle behind it ends in the conus medullaris forming a slight dilatation, the ventricularis terminalis. It is lined by ciliated epithelium.



GRAY MATER

- The gray mater of the spinal cord in transverse section resembles roughly the capital letter 'H.'
- The cross bar being the gray commissure. Each half consists of a dorsal and a ventral horn.
- The dorsal horn is elongated, narrow and reaches the surface of the cord at the dorsolateral fissure at the entrance of the dorsal root fibres. It contains sensory neurons.
- The apex of the dorsal column is covered by a mass of translucent nervous tissue called substantia gelatinosa that contains cell bodies in the pain and thermal pathways. From the middle of the cervical region to the lumbar region, there is a medial projection of gray mater at the ventral part of the dorsal column known as nucleus dorsalis.
- A pointed projection from the lateral surface of gray mater, opposite the gray commissure is known as lateral horn or intermedio-lateral column and is seen only in the thoracic, lumbar and middle sacral levels. It contains autonomic motor neurons.
- The ventral horn is rounded, wider and is separated from the surface of the cord by the white mater through which pass the ventral root fibres. It contains somatic motor neurons.

WHITE MATER

- The white mater is divided into three pairs of columns.
- The dorsal column lies on either side of the dorsal median septum to the dorsolateral groove.
- The ventral column is situated between the ventral median fissure and the ventral root. These are connected by the white commissure.
- The lateral columns are included between the dorsal and ventral root fibres. The amount of gray and white mater differs in different regions.
- The gray mater increases from the cervical to the sacral region.

- The white mater consists chiefly of medullated nerve fibres arranged in three columns or funiculi. Some of the fibres cross in the median plane to the opposite side through the white commissure but the majority directed to the same side.
- The latter are chiefly of three classes
    - Those which carry impulses from the periphery to the centre called ascending sensory or afferent tracts
    - Those which carry impulses from the centre to the periphery - descending motor or efferent tracts
    - Those which connect the different segments of the cord - the intersegmental tract.
- The nerve tracts or fasciculi are not recognizable in the natural state but their identity has been established by special methods.
- The spinal cord of a medium sized ox is about 1.6 to 1.7 m long and weighs 2-2.5kg.

TRACTS OF SPINAL CORD

- These consist of bundles of medullated nerve fibres in the dorsal, lateral or ventral white columns or funiculi of the white mater of spinal cord. The fibres having similar origin, termination and function are grouped together and are called as tracts or fasciculi.
- The tracts may be classified as

Sensory or ascending tracts

- Sensory or ascending tracts conveying impulses from the periphery to the brain.
- They are generally formed (with exceptions) by the axons of neurons in the dorsal gray column, which in turn receive sensory impulses from the peripheral receptors, through the dorsal roots of spinal nerves after relay in the spinal or dorsal root ganglia. View animation

Motor or descending tracts

- Motor or descending tracts conveying impulses from the brain to the peripheral effectors.
- They arise from different centres or nuclei in the brain, descend in the white mater of spinal cord and finally end in synaptic relations with either somatic motor neurons in the ventral gray column (supplying skeletal muscle) or visceral motor neurons in the lateral gray column (supplying glands, plain muscle and cardiac muscle). View animation

Intersegmental tracts

- Intersegmental tract connecting different segments of the spinal cord.

TRACTS IN DORSAL WHITE COLUMN

- Fasciculus gracilis
- Comma tract
- Fasciculus cuneatus.
- The first two are ascending tracts conveying the same types of sensations.
- Fasciculus gracilis conveying impulses from the posterior parts of the body (posterior thoracic, lumbar, sacral and coccygeal) and the Fasciculus cuneatus conveying impulses from the anterior half (anterior cervical and thoracic).
- Both are in the dorsal white column, the F. gracilis being medial. The fibres in these tract are derived from the dorsal root of spinal nerves (without synapses in the dorsal gray column neurons) pass on the same side to the medulla oblongata, where they end in the gracile and cuneate nuclei.

- Fibres from these nuclei form the internal arcuate fibres curve towards the median line decussate and then continue as the medial lemniscus to terminate in the sensory nuclei in the thalamus. From here, the impulses are relayed to the sensory area in the cerebral cortex through the internal capsule.
- Both the tracts convey proprioceptive and discriminative touch or tactile sensations.

TRACTS IN LATERAL WHITE COLUMN

Ascending tracts

- *Lateral spino thalamic tract:*
  - It lies medial to the preceding. The fibres arise from the dorsal horn of the opposite side cross the median plane and ascend through the medulla.
  - It ascends as the spinal lemniscus and reaches the ventral portion of the lateral nucleus of the thalamus from where they are relayed to cerebral cortex.
  - The tract conveys impulses of pain and temperature.
- *Dorsal spino-cerebellar tract:*
  - This is situated at the periphery of the lateral column. Medially, it is in contact with the crossed pyramidal tract.
  - It begins about the second or third lumbar segment and passes into the cerebellum through the restiform body.
  - Its fibres arise from the nucleus dorsalis of the same side.
- *Ventral spino-cerebellar tract:*
  - It is a crescentic, flattened band that is situated at the periphery of the lateral white column below the preceding.
  - The fibres arise from the nucleus dorsalis and adjoining dorsal horn of the same and opposite sides.
  - The tract extends from the upper lumbar region to the upper part of the pons, then into the anterior cerebellar peduncle to reach the cerebellum.
  - These tracts carry the impulses of the proprioceptive sensibility from the locomotor apparatus to cerebellum, essential for adjustments of muscle tonus and synergic control during the performance of the voluntary movements.
- *Spino-tectal tract:*
  - It is placed medial to the ventral spino-cerebellar tract and the lateral spino-thalamic tract.
  - The fibres arise from the dorsal horn of the opposite side, cross the median plane; ascend to the mid brain where they terminate in the anterior quadrigeminal body.
  - This is an afferent pathway for spino-visual reflexes, resulting in movements of eye toward the source of stimulation.

Descending tracts

- *Cortico-spinal or Crossed pyramidal tract:*
  - It is a motor tract in the lateral white column.
  - Its fibres are the axons of the pyramidal cells of the motor area of the cerebral cortex of the opposite side.
  - The fibres descend through the internal capsule and crura cerebri enter the medulla oblongata, decussate and appear on the inferior face of the medulla as inferior pyramids.
  - They descend into the lateral column and end by synapses around the motor cells of the ventral horn. This is the motor pathway that controls all voluntary actions involving skeletal muscles.
- *Rubro-spinal tract:*
  - This is ventral to the preceding and appears as a triangular area on section.

- Its fibres arise from the red nucleus of the midbrain and descend in the lateral column to end around the motor cells of the ventral horn of the cord.
- Through this tract the ventral horn cells are brought under the control of cerebellum and corpus fstriatum.
- The former exercises synergic control while the latter controls the automatic associated movements.

- *Tecto-spinal tract:*
  - This is ventral to the preceding.
  - The fibers arise from the tectum or upper part of midbrain consisting of anterior and posterior colliculi and immediately decussate (in the midbrain) descends in the lateral white column of spinal cord to end in the ventral horn cells of the spinal cord.
  - This serves as an efferent pathway for visuospinal and auditospinal reflexes.

TRACTS IN VENTRAL WHITE COLUMN

Ascending tract

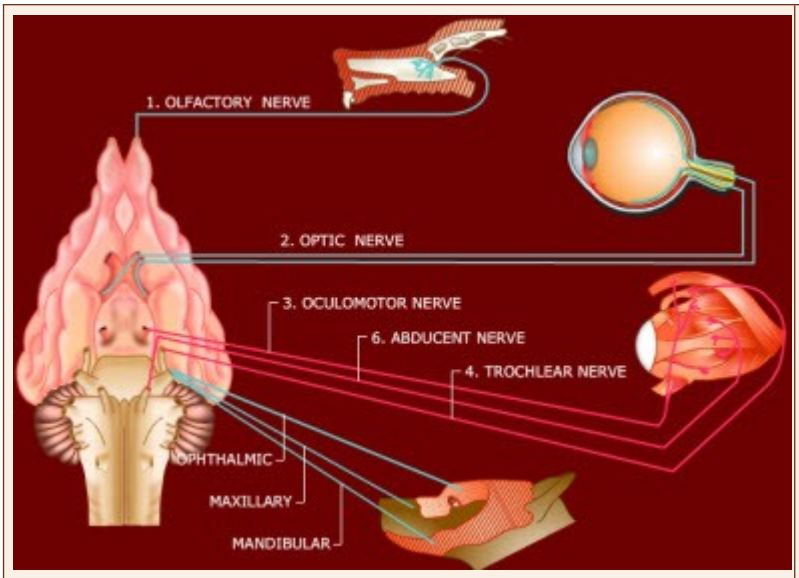
- Ventral spino -thalamic tract:
  - This ascending tract consists of fibres derived from the sensory neurons of dorsal gray column, which ascend directly upto two or three segments and then cross to the opposite side to reach the ventral white column.
  - They pass up to the thalamus, from where they are relayed to the sensory area of cerebral cortex. This tract conveys coarse touch and pressure sensations.

Descending tract

- Vestibulo-spinal tract:
  - It arises from the vestibular nuclei in the medulla oblongata and ends around the motor neurons of ventral gray column.
  - This serves as an efferent pathway for impulses from the vestibular organ and for bringing about coordination of body musculature in the maintenance of equilibrium, etc.
- Reticulo-spinal tract:
  - The fibres arise from the cells in the reticular formation of brain stem, descend in the ventral white column and end in synaptic relations with the somatic motor neurons in the ventral gray column and also with the visceral motor neurons in the lateral gray column.
  - This tract serves as a pathway for
    - Autonomic or visceral efferents from hypothalamic centres and other areas of the brain
    - Regulation of reflex activity of skeletal muscles (facilitating and inhibiting reflexes, regulation of rhythmic activity of muscles as in respiration etc.)
    - Adjustment of threshold for transmission of sensory impulses.

- Intersegmental tract:
  - The remaining part of the column constitutes this tract. It connects different segments and some fibres go to form the median longitudinal bundle.

MODULE-19: CRANIAL NERVES



LEARNING OBJECTIVES

- To study the origin type, course and distribution of the twelve cranail nerves and thier innervation.
- To have a better understanding about the functioning of these twelve cranial nerves and thier actions on the target organs,
- It will help the clinician to examine the nerves and thier innervation and to test their reflexes.
- To examine their efficiency in case of trauma or injury to the nerve branches and in conditions of paralysis.
- It will help in performing nerve blocks as a premedication for surgery.

CLASSIFICATION OF CRANIAL NERVES

No.	Name	Kind	Origin
1.	Olfactory nerve	Nerve of special sense (smell)	Fore Brain
2.	Optic nerve	Nerve of special sense (sight)	Fore Brain
3.	Oculo Motor Nerve	Motor nerve	Fore Brain
4.	Trochlear Nerve	Motor Nerve	Fore Brain
5.	Trigeminal Nerve	Mixed nerve	Mid Brain

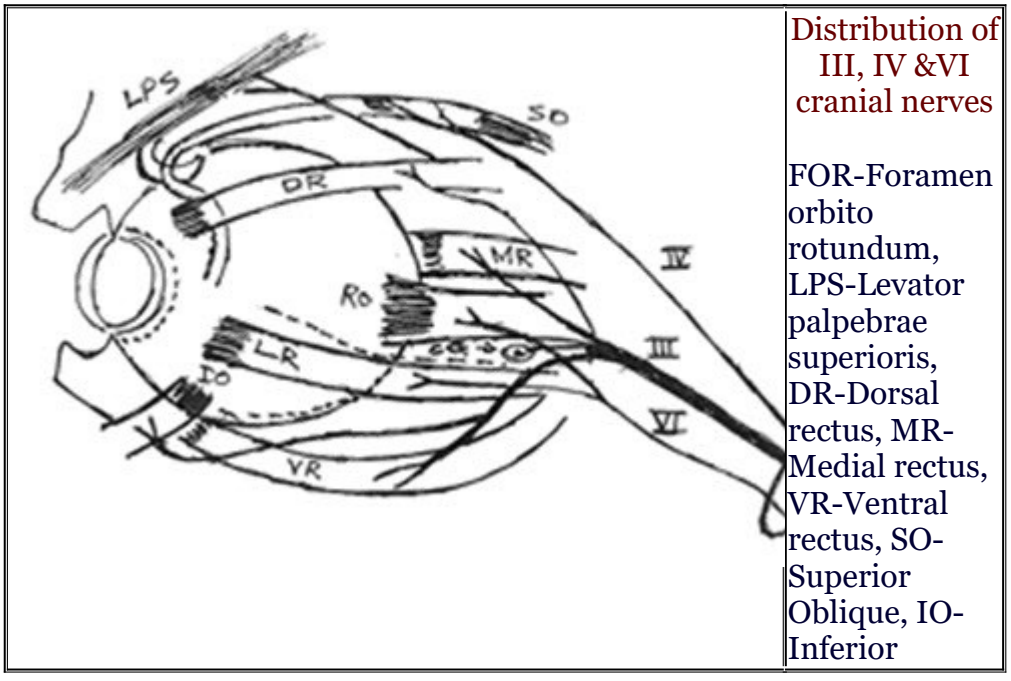
6.	Abducent Nerve	Motor nerve	Mid Brain
7.	Facial nerve	Mixed nerve	Mid Brain
8.	Acoustic Nerve	Nerve of special sense (hearing & equilibrium)	Mid Brain
9.	Glosso pharyngeal	Mixed nerve	Hind Brain
10.	Vagus nerve	Mixed nerve	Hind Brain
11.	Spinal Accessory	Motor nerve	Hind Brain
12.	Hypoglossal nerve	Motor nerve	Hind Brain

OLFACTORY NERVE (SENSORY)

- It is a nerve of special sense for smell.
- It consists of fibres which are the axons of the olfactory cells in the olfactory part of the nasal mucous membrane.
- The fibres are non-medullated and are collected into small bundles enclosed in sheaths furnished by the meninges of the brain; pass through the cribriform plate of the ethmoid and join the convex face of the olfactory bulb.

OPTIC NERVE (SENSORY)

- It is a nerve of sense for sight. This nerve is composed of medullated fibres devoid of neurilemma which are axons of the ganglion cells of retina.
- The fibres converge within the eyeball at the optic papilla, where they form the optic nerve.



Distribution of III, IV &VI cranial nerves

FOR-Foramen orbito rotundum, LPS-Levator palpebrae superioris, DR-Dorsal rectus, MR-Medial rectus, VR-Ventral rectus, SO-Superior Oblique, IO-Inferior

	oblique, RO-retractor oculi, Cg-Ciliary ganglion *Note: The ciliary ganglion relays parasympathetic fibres to ciliary muscles and constrictor pupillae*

- Then it pierces through the choroid and sclera, emerges from the inferio-lateral quadrant of the eye and passes backward and inward to the optic foramen.
- On entering the cranium the two nerves decussate at the base of the brain and form the optic chiasma or commissure.
- From the optic commissure, the optic tract passes into the lateral geniculate body and anterior quadrigeminal body.
- The sheath of the nerve is formed by the prolongation of the meninges of the brain.

OCCULOMOTOR NERVE (MOTOR)

- It is the motor nerve to the muscles of the eyeball.
- It arises from the ventromedial aspect of the cerebral peduncle turns sharply outward and forward, crossing over the posterior primary branch of the emergent artery of the rete mirabile cerebri through the cavernous sinus along with the ophthalmic and the sixth cranial nerves.
- It leaves the cranium through the foramen orbito rotundum, enters the orbit, pierces the periorbita and divides into dorsal and ventral branches.
- The dorsal branch supplies medial rectus, ventral rectus and ventral oblique muscles and also conveys parasympathetic efferents to the ciliary ganglion that after relay in the ganglion are distributed to the ciliary muscle and constrictor pupillae of iris.

TROCHLEAR NERVE (MOTOR)

- It is the motor nerve to the superior oblique muscle of the eyeball. It is the finest of the cranial nerves.
- It arises from the dorsal aspect of midbrain close to and behind the corpora quadrigemina where the anterior cerebellar peduncle enters the midbrain.
- The nerve passes forward and outward along the lateral border of the fifth cranial nerve, through the cavernous sinus and leaves the cranium through the foramen orbitorotundum and supplies the superior oblique muscle of the eyeball.

TRIGEMINAL NERVE (MIXED)

- It is a mixed nerve. It is the largest of the cranial nerves.

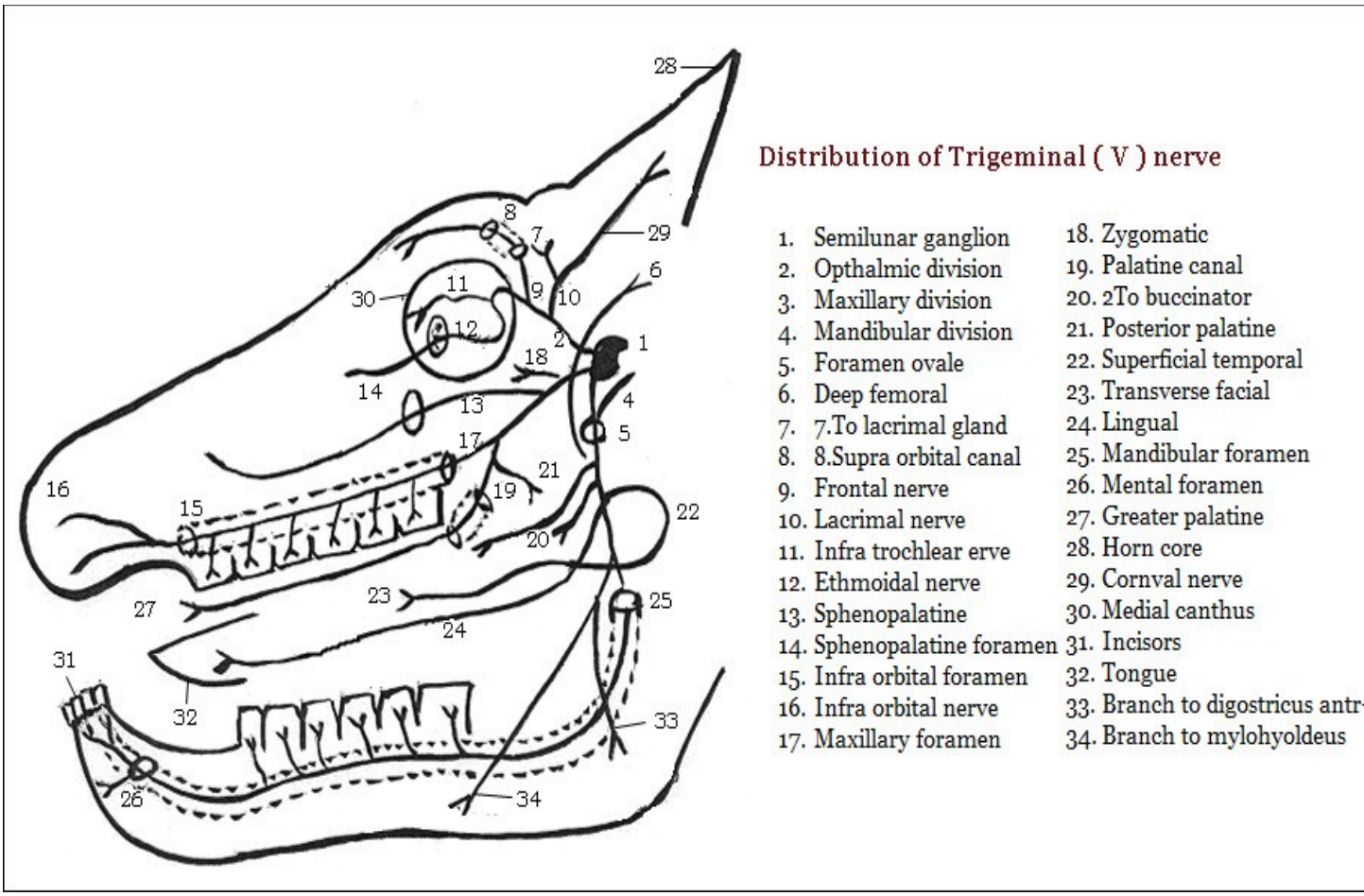
- It is connected to the lateral aspect of the pons by a large sensory root and a small motor root; the sensory root forms the semilunar ganglion under which the motor root passes forward.
- The convex face of the ganglion gives off three branches, the ophthalmic, maxillary and mandibular nerves.

Opthalmic nerve

- The ophthalmic nerve is purely sensory and leaves the cranium through the foramen orbitorotundum and divides into frontal, lacrimal and naso ciliary branches.
- The frontal nerve emerges from the orbit through the supraorbital canal and supplies the upper eyelid and the skin.
- The lacrimal nerve supplies the lacrimal gland, skin over the temporal fossa, frontal sinus and a long cornual branch that passes below the lateral border of the body of the frontal bone along with the branches of superficial temporal artery and vein to supply the corium of the horn.
- The naso ciliary nerve runs toward the ethmoidal foramen where it divides into the ethmoidal nerve and the infra-trochlear nerve.
- The ethmoidal nerve passes through the ethmoidal foramen into cranial cavity and leaves it through the cribriform plate of ethmoid and supplies the nasal mucous membrane. (View the branches of Nerves to the facial region)
- The infratrochlear nerve runs towards the medial canthus and supplies the conjunctiva, lacrimal ducts, lacrimal sac and the third eyelid.

Maxillary nerve

- The maxillary nerve is the largest of the three branches and is also purely sensory like the ophthalmic.



- It emerges out of the cranium through the foramen orbitorotundum runs forward in the pterygopalatine fossa and gives off the following branches.
    - zygomatic or orbital branch which runs to the lateral canthus and supplies lower eyelid and skin.
    - sphenopalatine nerve that is given off in the pterygopalatine fossa, bears the sphenopalatine ganglion. It divides into
        - posterior nasal nerve passes through sphenopalatine foramen to supply the nasal mucous membrane.
        - the greater or anterior palatine which runs through the palatine canal and groove to supply hard palate and gums.
        - the lesser or posterior palatine which passes downward to supply the soft palate.
    - Then the maxillary nerve continues as the infraorbital nerve, which passes through the infraorbital canal, gives off dental branches to the upper cheek teeth, alveolar periosteum and gums, emerges out of the infraorbital foramen and divides into nasal and labial branches to supply nostril and upper lip, respectively.

MANDIBULAR NERVE

- The mandibular nerve is a mixed nerve. Its sensory root arises from the semilunar ganglion soon after it is joined by the motor root. The motor fibres supply only the muscles of mastication. The mixed nerve thus formed leaves the cranium through the foramen ovale, runs downwards between the pterygoids, enters the mandibular foramen of the mandible, runs through the inferior dental canal and gains exit at the mental foramen. Before entering the mandibular canal. It gives off a number of branches in its course.

- *Masseteric nerve:* Passes through the mandibular notch enters the deep face of the masseter and supplies it.
- *Deep temporal:* To supply temporalis muscle.
- *Buccinator nerve:* Passes downward and forward on the medial aspect of temporo mandibular articulation, runs downward in the submucous tissue of the cheek and supplies mucosa of the cheek.
- *Pterygoid nerve:* Arises in common with the preceding and supplies the pterygoid muscles and branches to tensor palati and tensor tympani.
- *Mylohyoid nerve:* Passes downward to supply the mylohyoideus muscle and also the anterior belly of digastricus.
- *Superficial temporal nerve:* Passes backward to the posterior border of the mandible a little below its neck turns outward and then forward under the parotid lymph gland and divides into transverse facial nerve, supplying skin of the cheek and a ventral branch which unites with the dorsal buccal division of the facial nerve. It also gives a branch to parotid salivary gland that conveys postganglionic secretomotor fibres from otic ganglion.
- *Lingual nerve:*Runs downwards and forward between the ramus of the mandible and medial pterygoid muscle to the root of the tongue, where it divides into a superficial branch, which accompanies the mandibular duct on the deep face of the sublingual gland and supplies the mucous membrane of the tongue and floor of the mouth and a deep branch, which runs between hyoglossus to the tip of the tongue. It supplies the mucous membrane of the anterior two third of the tongue.

- In the course of the mandibular nerve through the mandibular canal,it supplies dental branches to lower cheek teeth, and sends a branch through the incisor canal to supply lower incisors. After emerging out of the mental foramen, the nerve divides into a number of labial filaments to supply the lower lip.

ABDUCENT NERVE (MOTOR)

- This is a motor nerve.
- It arises just behind the pons, lateral to the inferior pyramid of the medulla.
- It passes forward across the pons, pierces the dura and accompanies the nerves in the cavernous sinus.
- It leaves the cranium through the foramen orbitorotundum reaches the orbit and supplies the lateral rectus and retractor oculi.

FACIAL NERVE (MIXED)

- This is the seventh cranial nerve and is a mixed nerve. It arises from the lateral part of the corpus trapezoideum immediately behind the pons.
- It passes outwards across the fifth cranial nerve and in front of the eighth cranial nerve and enters the internal auditory meatus with it. At the bottom of this meatus the two nerves get separated and the facial nerve enters the facial canal passes in it at first, directed outward, then curves backward and ventrally into the posterior wall of the tympanum to end at the stylo mastoid foramen.
- The bent part of the nerve is the genu and bears at its highest point the geniculate ganglion. After its emergence through the stylo mastoid foramen, the nerve passes forward and outward under the parotid salivary gland where it terminates into dorsal and ventral buccal nerves.

- The following branches are detached within the facial canal.
  - Great superficial Petrosal nerve: It arises from the geniculate ganglion in the facial canal, passes backward, reaches the cranial cavity through the internal auditory meatus, emerges through the foramen lacerum and is continued as the nerve of pterygoid canal to sphenopalatine ganglion. This nerve conveys parasympathetic (preganglionic) fibres to the lacrimal gland and glands of nasal mucosa that after relay in the spheno palatine ganglion, are conveyed to these structures in the respective branches of the trigeminal nerve.
  - Stapedial nerve: It is detached as it turns in the facial canal. It supplies stapedius muscle in the middle ear.

- Chorda tympani nerve: It is given off a little below the preceding. It enters the tympanic cavity, passes across it and then descends and emerges through the petrotympanic fissure, gains the company of the lingual branch of the fifth nerve and supplies gustatory fibers to the anterior two third of the mucous membrane of the tongue. It also supplies secreto motor fibres to the submaxillary and sublingual salivary glands through the submandibular ganglion. After emergence through the stylomastoid foramen, the facial nerve gives off the following branches:
- Posterior auricular nerve: Which runs upward and backward under the parotid gland and supplies posterior auricular muscles.
- Internal or deep auricular nerve: Passes through a foramen in the conchal cartilage and supplies skin on the internal surface of the external ear.
- Digastric branch: Descends below under the cover of parotid gland and supplies the posterior belly of digastricus, occipitohyoideus and stylohyoideus.
- Auriculo palpebral nerve: Passes upward under the parotid gland and divides into anterior auricular branch supplying anterior auricular muscles and palpebral or temporal nerve which runs forward to supply orbicularis oculi, corrugator supercilli and levator nasolabialis.
- A cervical branch that passes under parotid gland and parotidoauricularis muscle downward and backward and anastomoses with cutaneous branches of cervical spinal nerves.
- Of the two terminal branches, the dorsal buccal nerve passes forward on the upper part of masseter and is joined by a branch from the superficial temporal division of the trigeminal nerve. It continues forward under zygomaticus and along the ventral border of dilator naris lateralis and ramifies on the muscles of the upper lip and nostril. It also supplies zygomaticus, malaris and buccinator. It anastomoses with ventral buccal nerve and receives a communicating branch along the anterior border of masseter.
- The ventral buccal nerve passes downward obliquely across the lower part of masseter, runs forward along the ventral border of depressor labii inferioris. It supplies the muscles of the lower lip. (View the Nerves supplying the face)

ACOUSTIC /AUDITORY/VESTIBULO- COHLEAR NERVE

- This is the nerve of sense of hearing and equilibrium.
- It arises from the medulla at the lateral part of the corpus trapezoideum just behind the preceding nerve.
- It has two roots vestibular and cochlear.
- The nerve passes outward along with the facial to the internal auditory meatus. Here it divides into two branches an upper vestibular and the lower cochlear nerves.
- In the internal auditory meatus this nerve presents the vestibular ganglion.
- The peripheral processes of the cells of the ganglion are then distributed to the maculae of the utricle and the saccule, and the cristae ampullaris of the semicircular canals of the internal ear.
- The cochlear nerve detaches a filament to the saccule and passes through the modiolus and joins the spiral ganglion.
- The peripheral processes of the cells of the ganglion run in the lamina spiralis and are distributed to the organ of corti in the cochlea.

GLOSSO PHARYNGEAL NERVE

- This is a mixed nerve. It is attached to the lateral part of the medulla at its anterior aspect by several filaments ventral to the restiform body and are separated by a narrow interval from the preceding nerve in front and the vagus behind.
- The nerve fibres converge laterally into a bundle that pierces the dura, emerges through the foramen lacerum and then bears a ganglion called petrosal ganglion. It then curves forward and downward, behind the great cornu of the hyoid divided into the pharyngeal and the lingual branches. Its branches are
    - The tympanic nerve arises from the petrosal ganglion passes upward between the petrous and tympanic parts of the temporal bone to reach the cavity of tympanum. Here it forms along

with branches from the plexus of the sympathetic, the tympanic plexus. From the plexus, branches pass to the mucous membrane of the tympanum and pharyngotympanic tube. The continuation of the nerve from the plexus joins a branch from the geniculate ganglion. The lesser superficial petrosal nerve conveys parasympathetic fibres supplying the parotid salivary gland, after relay in the otic ganglion.

- a small branch to supply stylopharyngeus muscle.
- Pharyngeal branch with which branches of vagus and sympathetic forms the pharyngeal plexus and supplies the mucous membrane of the pharynx.
- The lingual branch supplies gustatory and ordinary sensory fibres to the posterior one third of the tongue. It also supplies soft palate, tonsil and isthmus faucium.

VAGUS OR PNEUMOGASTRIC NERVE

- This is a mixed nerve.
- It is the longest and the most widely distributed of all the cranial nerves.
- It is attached to the lateral aspect of the medulla oblongata by several filaments, which arise in a series with those of the glossopharyngeal in front and the spinal accessory behind.
- The bundles converge to form a trunk that passes outward pierces the dura and emerges out of the cranium through the foramen lacerum. In the foramen, it bears the jugular ganglion. Beyond this, it runs backward and downward with the eleventh cranial nerve. Then the two nerves separate and the twelfth cranial nerve passes between them.
- It descends along with cervical sympathetic to form a common vago-sympathetic cord on the dorsal part of the carotid sheath above carotid artery and descends deeply in the jugular furrow and enters the thorax.

Collateral branches

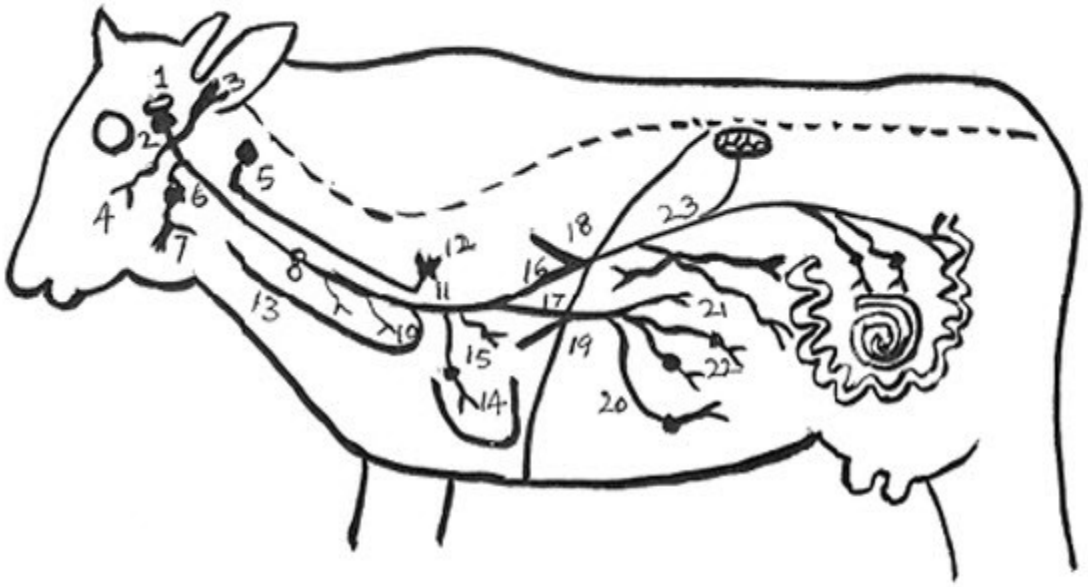
- The right vagus crosses under the right brachial artery across the trachea, reaches the oesophagus behind the aortic arch and divides into dorsal and ventral branches.
- The left vagus enters the thoracic cavity, passes under the arch of the left brachial artery and the root of the aorta, reaches the left lung and then across the surface of the oesophagus, divides into dorsal and ventral branches.
- The two dorsal and the two ventral branches of the vagi unite forming the two trunks dorsal and ventral oesophageal continuations of the vagi on the respective faces of the oesophagus, which pass through the diaphragm into the abdominal cavity to supply the abdominal organs.

- The *auricular branch* from the jugular ganglion enters the facial canal, emerges out at the stylomastoid foramen passes through the foramen in the conchal cartilage and supplies branches to the lining membrane of the external ear.
- The *pharyngeal branch* along with the pharyngeal branch of glossopharyngeal and the sympathetic fibres form a plexus from which motor fibres are supplied to the pharyngeal constrictors, muscles of soft palate except tensor palati.
- The *anterior laryngeal nerve* presents at its origin the ganglion nodosum. It arises at about the level of the division of the carotid artery, supplies sensory branches to the mucous membrane of the larynx and an external laryngeal branch for the cricothyroid muscle.
- In the neck, the vagus gives off branches to trachea and oesophagus.
- In the thoracic cavity, the vagus gives off the following branches
    - *Cardiac branches* to the heart.
    - *Pulmonary branches* to the lungs.
    - *The posterior or recurrent laryngeal nerve:* It arises from the vagus at different levels on the two sides. The right is in advance of the left at the posterior border of the first rib, gives off sensory branches to the trachea and oesophagus, leaves the thorax, passes up the neck in the jugular furrow inside the carotid sheath below the common carotid artery and gives off branches to all the laryngeal muscles except the cricothyroid.

- The left recurrent laryngeal arises at the level of the base of the heart, winds round the right face of the aortic arch, passes forward, gives off sensory branches to the trachea and oesophagus, leaves the thorax, passes in the neck deeply in the jugular furrow along the ventral face of the oesophagus which separates it from the carotid sheath. It reaches the larynx and is distributed to the muscles of the larynx as on the right side.

- In the abdominal cavity, the dorsal and ventral oesophageal trunks are distributed as follows:
- The dorsal trunk gives off
  - Branch accompanying omaso abomasal artery and its divisions and supplies omasum and abomasum.
  - Branches which accompany splenic, right and left ruminal arteries, supply corresponding organs
  - Branches which accompany the divisions of anterior mesenteric artery, supply the small and large intestines except the terminal colon and rectum
  - Branches to kidney.
- The ventral trunk passes on the right face of reticulum and terminates on the parietal surface of the abomasum. It gives off the pyloric branch which passes along the lesser omentum to supply the liver, first and second parts of duodenum and pyloric part of abomasum.

Distribution of Vagus (X) nerve



1.Foramen lacerum, 2.Jugular ganglion, 3.Auricular, 4.Pharyngeal, 5.Superior cervical (Sympathetic ganglion), 6.Ganglion nodosum, 7.Anterior laryngeal, 8.Common cord of vagus and sympathetic in carotid sheath, 9. To oesophagus, 10.To trachea, 11.Sympathetic trunk leaving vagus to join, 12.Stellate ganglion, 13.Recurrent laryngeal, 14.Cardiac branches, 15.Pulmonary branches, 16.Dorsal divuision, 17.Ventral division, 18.Dorsal oesophageal trunk formed by union of dorsal divisions of Right and left vagi.19.Ventral oesophageal trunk formed by union of ventral divisions of right and left vagi.20. Pyloric nerve to pylorus of abomasums and first part of the duodenum, 21.To liver, 22.To rumen, 23.To kidney, small and large intestines except terminal colon and rectum.

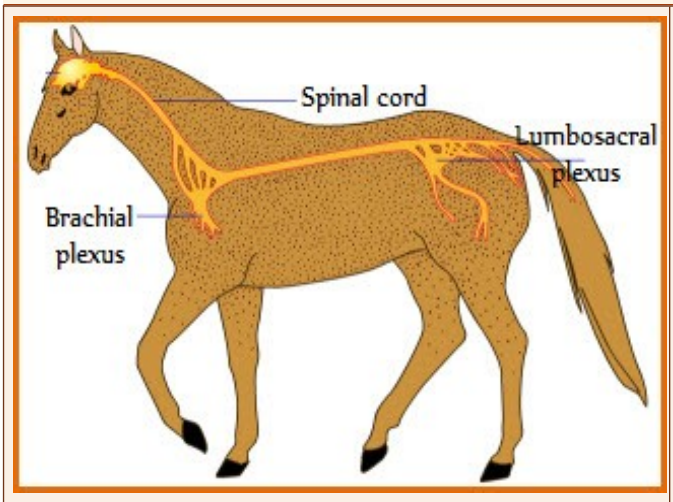
SPINAL ACCESSORY NERVE (MOTOR)

- This is a motor nerve. It has two roots, the medullary and spinal.
- The medullary root arises from the lateral aspect of the medulla by several rootlets behind and in a series with those of the vagus.
- The spinal root arises from the cervical part of the spinal cord by a series of fasciculi arising from the first five segments that unite to form a trunk and this root enters the cranium through the foramen magnum and joins the medullary root.
- The nerve thus formed leaves the cranial cavity along with the vagus, through the foramen lacerum and passes downward and backward, leaves the company of the vagus passes under the deep face of mandibular salivary gland passes backward winding round the wing of atlas and divides into dorsal and ventral branches.
- The dorsal branch passes backward under brachiocephalicus and ramifies on the deep face of trapezius.
- The ventral branch passes downward across the oesophagus and trachea and supplies sternocephalicus.

HYPOGLOSSAL NERVE (MOTOR)

- It is the motor nerve to the muscles of the tongue. Its fibres arise from the ventral face of the medulla oblongata in a series lateral to the posterior half of the pyramid.
- The filaments converge into three or four bundles that perforate the dura and unite to form the nerve.
- The nerve then emerges through the hypoglossal foramen runs downward and backward related to the atlantooccipital articulation.
- It passes between the tenth and the eleventh nerves, bends downward and forward, passes over the glossopharyngeal nerve and the great cornu of the hyoid bone.
- It gains the lateral face of the hyoglossus muscle and divides into branches to supply the muscles of the tongue.

MODULE-20: SPINAL NERVES



LEARNING OBJECTIVES

- To study in detail about the origin, number, course and distribution of the spinal nerves in cervical, thoracic, lumbar and sacral region.
- To study elaborately on the innrvation of forelimb and hindlimb muscles by the two major plexus, brachial plexus and lumbosacral plexus.
- To study the innervation of thoracic and abdominal musclature, sacral and coccygeal muscles.
- It will help the clinician to

	examine the feflex pathways and functioning of the spinal nerves and their efficiency in case of trauma and palsy. • It will help in performing nerve blocks in forelimb, trunk and hindlimb as premedication for surgery

CERVICAL SPINAL NERVES

- There are eight pairs of cervical spinal nerves.
- The first of these emerges through the intervertebral foramen of atlas, the second through the border of the arch of the axis and the eighth between the seventh cervical and the first dorsal vertebrae.
- First cervical
    - The dorsal branch supplies the anterior oblique and the dorsal straight muscles of the head and skin.
    - The ventral branch passes out through the alar foramen of atlas, runs across the rectus capitis ventralis major divides near the thyroid gland into anterior and posterior branches.
    - The former to supplies the omohyoideus and the latter joins a branch of the second cervical to supply the sternothyrohyoideus.
- Second cervical
    - The dorsal branch supplies the muscles and the skin of the occipital region.
    - The ventral branch supplies the rectus capitis ventralis major, sternothyrohyoideus and anastomotic branches to the spinal accessory nerve and ventral divisions of first and third cervical nerves.
    - It also supplies a posterior auricular branch to skin on the convex face of external ear and a cutaneous branch to the parotid region.
- Third cervical
    - Its dorsal branch supplies the intertransversales colli, multifidus cervicis and complexus.
    - The ventral branch supplies the longus colli, rectus capitis ventralis major, brachiocephalicus, splenius and longissimus capitis et atlantis.
- Fourth cervical
    - Similar to the preceding.
- Fifth cervical
    - Similar to the preceding.
    - In addition to supplying the lateral cervical group of muscles it gives a branch to the brachial plexus and another branch to form one of the roots of the phrenic nerve.
- Sixth cervical
    - Similar to the preceding. In addition to supplying the lateral cervical group of muscles it gives a branch to the brachial plexus and another branch to form one of the roots of the phrenic nerve.
- Seventh cervical
    - The dorsal branch is small and supplies the longissimus dorsi and multifidus dorsi.
    - The ventral branch gives off a fine branch that forms one of the roots of phrenic nerve and then goes to form the brachial plexus.
- Eighth cervical
    - The dorsal branch is small and is like that of the seventh.
    - The ventral branch contributes to form the brachial plexus.

THORACIC SPINAL NERVES

- There are thirteen pairs of dorsal spinal nerves and their arrangements are almost similar.
- The dorsal branches pass up into the intertransverse space and divide into medial and lateral branches of which the former supply the spinal muscles and skin of the region.
- The lateral branches are directed upward, pass through the longissimus dorsi and appear between it and the transversalis costarum. They break off into filaments to supply the skin.
- The ventral branches are the intercostal nerves. The first and second dorsal enter into the formation of the brachial plexus.
- The ventral branches of the rest are much larger than the dorsal branches and descend into the intercostal spaces in company with the vessels.
- At the upper half they run in between the intercostal muscles and supplies it.
- About the middle they comes out of the muscle as perforating branch supply the cutaneous muscle and skin of the thorax and abdomen.
- The intercostal nerves from the eighth to the thirteenth supply sensory branches to the diaphragm.

BRACHIAL PLEXUS

- This brachial plexus is a flat fasciculus of nerves placed between the medial face of the shoulder and the thoracic wall.
- It is formed by the convergence of the ventral primary branches of the sixth, seventh and eighth cervical and the first two dorsal spinal nerves.

- The plexus appears as a wide, white band at first between the scalenus and longus colli and then between the two divisions of the scalenus.
- The subscapularis and deep pectoral muscles cover it.
- Branches from the brachial plexus supply the muscles and integument of the forelimb and some of the muscles of the shoulder girdle and chest wall.
- The following are the branches of brachial plexus (View image)
    - External thoracic nerve
    - Thoraco dorsal nerve
    - Long thoracic nerve
    - Nerves to pectorals
    - Suprascapular nerve
    - Nerves to subscapularis
    - Nerve to teres major
    - Axillary nerve
    - Ulnar nerve
    - Musculocutaneous nerve
    - Median nerve
    - Radial nerve
- External thoracic nerve
    - This arises from the brachial plexus by a common trunk with the ulnar nerve.
    - It is at first placed medial to the ulnar nerve but leaves its company, passes backward to the deep face of the long head of triceps muscle, then along its deep face in company with the external thoracic vein, if present.
    - It gives off a number of branches to the deep pectoral, cutaneous muscle and terminates in the skin of the abdominal wall and one of its branch unites with the second and third perforating intercostal branches, winds round the ventral border of the latissimus dorsi and passing forwards, ramifies in the omobrachial part of the cutaneous muscle.
- Thoraco dorsal nerve
    - This nerve supplies latissimus dorsi.
    - Its fibres are derived from the eighth cervical and first dorsal.
    - It ramifies on the deep face of the muscle.
- Long thoracic nerve

    - The fibres of this nerve are derived from the seventh and eighth cervicals and sometimes from the sixth also and it supplies the serratus thoracis ventralis.
    - It is a thin and wide nerve and at first it passes backward under the deep face of the scalenus dorsalis on the posterior part of the serratus cervicis.
    - After giving a few branches to this muscle it gains the serratus thoracis and distributed to it.
- Nerves to pectorals
    - These are three or four in number and arise from the anterior part of the plexus and form the loop formed by the musculocutaneous and median nerves.
    - One of these passes to the deep face of the deep pectoral.
    - Another nerve passes to the superficial pectoral and brachiocephalicus.
- Suprascapular nerve
    - It is the most anterior of all the nerve from the brachial plexus and is fairly large.
    - It derives its fibres from the sixth and seventh cervicals, passes forward, downward and outward, gains the space between the supraspinatus and the subscapularis, turns around the lower fourth of the anterior border of the scapula, gains the supraspinous fossa, gives branch to the supraspinatus continues backward under the acromion process, passes into the infraspinatus muscle and terminates in it and teres minor.
- Nerves to subscapularis
    - They are two or three in number and are derived from the seventh and eighth cervical nerves.
    - These nerves are confounded at the origin with the thoracodorsal nerve, suprascapsular and circumflex nerves.
    - They supply the three divisions of the subscapularis.
- Nerve to teres major
    - It is derived from the *seventh* and eighth cervical nerves.
    - It crosses the subscapularis and the teres major and supplies branches to it and also the posterior part of the subscapularis.
- Axillary nerve
    - It arises from all the cervicals. It runs downward across the medial face of the lower part of the subscapularis, gains the space between the teres major and subscapular artery, gains the company of the posterior circumflex vessels, runs behind the shoulder joint reaches the deep face of the deltoideus.
    - It supplies teres major, deltoideus, teres minor and divides into dorsal and ventral branches.
    - The dorsal branch passes under the acromial head of deltoideus and ends in the terminal part of brachiocephalicus.
    - The ventral branch passes under the scapular head of deltoid, over the lateral head of triceps and continues down as the dorsal or anterior cutaneous nerve of forearm.
- Ulnar nerve (Note the supply of Ulnar nerve)
    - It derives its fibres from the first dorsal nerve.
    - It arises along with the median nerve by a short common trunk.
    - It first lies behind the brachial vessels then passes down receding from them, but keep company with the median nerve till about posterior, the middle of the arm. Here it detaches a long cutaneous branch to the skin on the posterior face of the forearm.
    - It then leaves the company of the median nerve, reaches the space between the olecranon process and the medial condyle of the humerus, gains the company of the collateral ulnar artery and vein, detaches an articular branch to the elbow and then disappears between the two heads of the flexor carpi ulnaris. Here it gives off branches to the two heads of the flexor carpi ulnaris, superficial flexor and ulnar head of the deep flexor.
    - The nerve then runs downwards under cover of flexor carpi ulnaris and between it and superficial flexor, then between the superficial flexor and ulnaris lateralis, detaches a few branches to the tendons and skin and divides about the lower third of the forearm into superficial and deep branches.
        - The superficial branch emerges between the two muscles, runs down subcutaneously behind the insertion of the tendon of the flexors, runs superficially over the carpal sheath downward and outward over the metacarpal region and is continued as the lateral dorsal abaxial digital nerve on the abaxial aspect of the lateral digit.
        - The deep branch descends deeply under the deep fascia behind the carpus over the carpal sheath, supplies branches to the suspensory ligament below the carpus, unites

about the fetlock with a branch of the lateral branch of the median and runs subcutaneously as the lateral volar abaxial digital nerve on the lateral digit.

- Musculocutaneous nerve
  - This nerve arises from the anterior part of the brachial plexus close behind the suprascapular nerve and derives its fibres chiefly from the seventh and eighth cervical nerves.
  - It descends on the medial face of the shoulder joint below which it joins the median nerve by a large short branch to from a loop in which the brachial artery passes.
  - One or two pectoral branches are given off from this nerve to the loop.
  - The nerve then runs in front of the median, in the space between the division of the coracobrachialis in company with the anterior circumflex vessels, gives off a branch to this muscle and reaches the biceps brachii and terminates in it.
- Median nerve (View the nerve supply to the flexors)
  - It derives its fibres from the eighth cervical and the first dorsal nerves.
  - It is united at its origin by a branch from the musculocutaneous nerve to form a loop in which the brachial artery is suspended.
  - It at first descends on the medial face of the brachial artery which it crosses obliquely, then runs down the arm in front of the brachial artery and at the elbow it crosses over it and gains its posterior aspect and lies on the medial ligament of the elbow.
  - It again crosses the artery below the elbow joint and lies behind the radius at the lower part of the medial ligament.
  - It passes below the elbow beneath the pronator teres. It then runs down along the forearm between the bone and the flexor carpi radialis.
  - It passes through the carpal sheath descends to the lower third of the metacarpus and divides into lateral and medial branches.
- *Collateral branches*
  - The musculo-cutaneous branch arises off from this nerve at about the middle of the humerus from its anterior face passes under the cover of biceps brachii and divides into muscular and cutaneous branches. The muscular branch supplies the brachialis.
  - The cutaneous branch supplies the skin in front and medial aspect of forearm.
  - Immediately below this, it gives off muscular branches to pronator teres, flexor carpi radialis, superficial flexor, humeral and radial heads of the deep flexor and a small interosseous nerve that accompanies the artery of the same name.
  - The terminal branches are medial and lateral.
  - The medial branch divides into medial and lateral divisions. Of which the former, after giving some small branches to the rudimentary digit is continued down as medial volar abaxial digital nerve.
  - The lateral division joins the medial division of the lateral branch to form the volar common digital nerve.
  - The lateral branch divides similarly into medial and lateral divisions.
  - The medial branch forms the volar common digital nerve and the lateral division joins the deep branch of the ulnar nerve to form the lateral volar abaxial digital nerves.
  - The volar common digital nerve passes into the interdigital space and divides into two volar axial digital nerves to supply the digits.
- Radial nerve
  - It is the largest nerve in the brachial plexus .
  - It remians subcutaneous below the elbow and prone to external pressure or injuries.
  - Its fibres are derived from the seventh and eighth cervical and first dorsal nerves.
  - The nerve passes downward and backward across the subscapularis and teres major and disappears in the space between the scapula, humerus and long head of triceps, passes in the musculospiral groove between the triceps and brachialis, reaches the anterior aspect of the elbow between the brachialis and extensor carpi radialis and emerges from under the lower part of the lateral head of triceps and descends on the anterior face of the forearm on the extensor carpi radialis over the deep fascia.
  - It continues down the anterior face of forearm in relation to cephalic vein and then down the carpus and metacarpus.

- At about the middle of metacarpus it detaches the medial dorsal abaxial digital nerve and continues down the metacarpus to divide into two dorsal axial digital nerves at the upper part of the interdigital space.

SACRAL SPINAL NERVES

- The dorsal branches are small, gain exit through the dorsal sacral foramina and supply the muscles and skin of the croup.
- The ventral branches of the first and second enter into the formation of the lumbo-sacral plexus.
- The third generally gives off a branch to the plexus and the rest unites with the fourth and divides into pudic and posterior haemorrhoidal nerves.
- The pudic nerve passes on the sacrosciatic ligament, gives off branches to the bladder, urethra and muscular branches to the muscles of the anus.
- At the ischial arch it supplies branches to ischiocavernosus, urethra, and corpus cavernosum penis in the male and vulva in the female and terminate in the clitoris.
- The pudic nerve in the male is continued around the ischial arch, descends on the dorsum penis to reach the glans penis. It supplies the erectile tissue and prepuce.
- The posterior haemorrhoidal nerve supplies the rectum.
- The ventral primary branch of the fifth is small and supplies the muscles of the anus and skin, compressor coccygeus and skin of the tail.

LUMBO SACRAL PLEXUS

- The lumbosacral plexus supplies the muscles of the hind limb.
- It is formed by the convergence of the ventral primary branches of the last three lumbar and first two or three sacral spinal nerves.

- This plexus is in two parts-anterior and posterior parts connected by anastomotic branches.
- The anterior part is formed by the fourth, fifth and sixth lumbar nerves and is situated between the psoas muscles while the posterior part is formed by the sixth lumbar, first and second sacral nerves and sometimes a branch of the third sacral and is on the pelvic face of the sacrosciatic ligament at the greater sciatic foramen.
- The nerves from the anterior part of the plexus are the iliopsoas, femoral and obturator nerves.
- The nerves from the posterior part are the anterior gluteal, sciatic and the posterior gluteal nerves. (View image)
- Ilio psoas nerve
  - It derives its fibres from the fourth lumbar and supplies psoas major, psoas minor and iliopsoas muscles.
- Femoral nerve
  - It derives its fibres from the fourth and fifth lumbar and is the largest nerve of the anterior part of the plexus.
  - It runs downward and backward between the psoas muscles, crosses the lateral face of the tendon of psoas minor, gets undercover of sartorius, lies on the termination of iliopsoas gives off a branch to the later, detaches the saphenous nerve and dips in between the rectus femoris and vastus medialis to supply the quadriceps femoris and articularis genu.
- Saphenous nerve
  - The saphenous nerve is detached a little above the brim of the pelvis as the femoral nerve crosses the tendon of psoas minor, passes down at first between the sartorius and vastus medialis (femoral canal) and then gives off a long branch which passes backward into the head of the pectineus.
  - The nerve gains exit with the saphenous artery and saphenous vein at the space between the sartorius and gracilis at about the level of the stifle, divides into several branches to supply sartorius and gracilis.

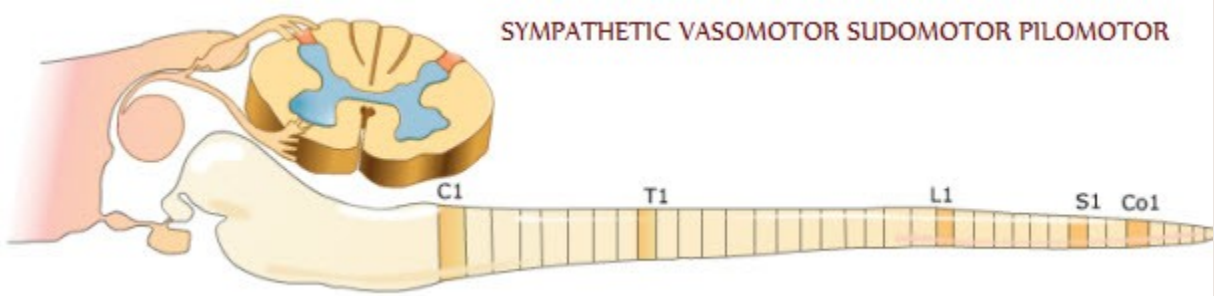
    - Two sets of the terminal branches penetrate the deep fascia and pass subcutaneously to supply the skin on the medial aspect of the leg.
- Obturator nerve
    - This nerve derives its fibres from all the three lumbar.
    - It passes downward and backward across the iliacus, then on the medial surface of the ilium covered by peritoneum then turns downward on the shaft of the ilium towards the obturator internus, passes through the obturator foramen, then through obturator externus supplying it and divides to supply pectineus, adductor and gracilis muscles.
- Anterior gluteal nerve
    - This is the anterior of the nerves derived from the posterior part of the plexus and is in front of the sciatic nerve.
    - Its fibres are derived from the sixth lumbar and the first sacral nerves.
    - It divides into four or five branches that leave the cavity through the greater sciatic foramen in company with the anterior gluteal vessels and then supply the gluteus medius and deep gluteus or gluteus profundus.
    - A long branch passes between these two muscles to supply the tensor fasciae latae.
- Posterior gluteal nerve
    - This nerve is behind the sciatic and its fibres are derived from the first and second sacrals.
    - It divides into branches that pass backward through the greater sciatic foramen over the gluteus medius and supply the upper part of the biceps femoris.
- Sciatic nerve
    - It is the largest nerve in the body. It is derived from the sixth lumbar and first and second sacral nerves.
    - It is a wide flat band, leaves the pelvic cavity through the greater sciatic foramen, passes downward and backward between the gluteal muscles, gains the hollow between the trochanter major and tuber ischii runs over the gemellus and quadratus femoris, bends downward, descends behind the thigh in a muscular canal bounded by the biceps femoris and semitendinosus laterally and adductor and semimembranosus medially, dips between the two heads of gastrocnemius and is continued as the tibial nerve. (View the nerve supply to the thigh)
- Collateral branches
    - A slender muscular branch that passes along its posterior border through the lesser sciatic foramen to the obturator internus. This nerve is given off in the midway between the two sciatic foramina.
    - A small muscular branch from the deep face of the sciatic, passes backward between the nerve and gluteus profundus, supplies gemellus and passes through it to supply the quadratus femoris.
    - A large muscular branch to supply the biceps femoris, semitendinosus and semimembranosus.
    - The posterior cutaneous nerve of the leg is detached from the sciatic about the middle of the thigh. It descends over the lateral head of the gastrocnemius under the cover of biceps femoris. It runs downward in company with the recurrent tarsal vein in front of the outer edge of the gastrocnemius tendon to the lower third of the leg. It divides here into a number of branches that are distributed to the skin on the lateral aspect of the tarsal and metatarsal regions.
    - The peroneal nerve is a very large trunk detached about the middle of the thigh. It descends in front of the sciatic to the origin of the gastrocnemius, crosses over the lateral head of this muscle obliquely downward and forward, gains the level of the origin of the lateral digital extensor and divides into superficial and deep peroneal nerves. It also gives off branches to biceps femoris and the lateral cutaneous nerve of the leg, which perforates through the biceps femoris and supplies the skin of the stifle region.
        - The *superficial peroneal nerve* supplies branches to the lateral digital extensor and then crosses beneath the peroneus longus, passes down between it and the lateral digital extensor to the lower third of the leg. It there after runs down between the lateral and long digital extensors, gains the dorsolateral face of the lower part of the hock, runs down subcutaneously over the annular ligaments, runs down the metatarsal region on the extensor brevis, gains the company of the dorsal superficial metatarsal vein and divides below into three branches of which the lateral and medial

are continued down as the lateral dorsal abaxial and medial dorsal abaxial digital nerves. The middle branch joins the dorsal branch of the deep peroneal to form the dorsal common digital nerve which divides into two dorsal axial digital nerves.

- The *deep peroneal nerve* at first dips between the lateral digital extensor and peroneus longus and then between the lateral and long digital extensors. It gives branches to all the muscles of the dorsolateral group of the leg and is continued down on the lateral border of the tendon of the long digital extensor and reaches the hock, gives off branches to extensor brevis, passes under the annular ligament, runs down the metatarsal groove in company with the dorsal metatarsal vessels and divides above the fetlock into dorsal and plantar branches. The dorsal branch joins a branch of the superficial peroneal and the plantar branch joins the branch of the median plantar nerve to form the plantar common digital nerve that divides into two plantar axial digital nerves.

- Tibial nerve
  - It is a continuation of the sciatic after it dips between the two heads of the gastrocnemius.
  - It passes along the posterior border of the superficial flexor of the digit and becomes subcutaneous by passing under the medial head of the gastrocnemius continues in front of the tendo-achilles on the medial aspect of the leg.
  - Its collateral branches supply all the muscles on the posterior aspect of the leg.

MODULE-21: AUTONOMIC NERVOUS SYSTEM



LEARNING OBJECTIVES

- To study the splanchnic component of nervous system.
- To study in detail on the sympathetic and parasympathetic nervous system and its components.
- To learn about the cranio-sacral outflow and thoraco-lumbar sympathetic chain, their origin, course and distribution to the target organ.
- It will help in better understanding on the sympathetic and parasympathetic function of various organs innervated by the respective nerve fibres.

SYMPATHETIC SYSTEM

- This is the larger subdivision of the autonomic system and includes two ganglionated cords with their branches, plexuses and includes two ganglia.
- It has a much wider distribution as it innervates all the sweat gland of the skin, arrectores pilorum muscles, muscular walls of blood vessels in addition to viscera.
- The preganglionic fibres of the thirteen thoracic and the first four lumbar segments of spinal cord are interrupted in the ganglia situated on either side of the vertebral column.
- The ganglia form a ganglionated trunk on either side of the vertebral column extending from the head to the sacrum.

- The number of ganglia correspond to the number of segments of the spinal cord in the thoracic, lumbar and sacral regions but in the cervical region (in the adult) there are generally only two ganglia superior and inferior and there is only one unpaired coccygeal ganglion.
- The preganglionic fibres arising from the lateral horn cells of spinal cord pass via the ventral root of the spinal nerve and enter the ganglion of the sympathetic trunk and from here, postganglionic fibres supply the viscera. Some of the postganglionic fibres join back the spinal nerve and supply vasoconstrictor fibres to blood vessels, sudomotor fibres join sweat glands and the pilomotor fibres to arrectores pilorum muscles.
- Thus the sympathetic ganglia are connected to the spinal nerve by a ramus communicans containing the preganglionic efferents from the spinal cord to the ganglia and afferents from viscera and by a gray ramus communicans containing postganglionic fibres from the ganglion which supply blood vessels, sweat glands and arrectores pilorum muscles.
- In addition to the ganglionated sympathetic trunk, the coeliac, anterior mesenteric and posterior mesenteric ganglia represent the collateral ganglia in which sympathetic efferents are relayed.
- These ganglia are present in the abdominal cavity on the walls of the corresponding arteries and the postganglionic fibres supply the viscera of the abdominal and pelvic cavities.

CLASSIFICATION OF SYMPATHETIC NERVOUS SYSTEM

- For purposes of description, the sympathetic system is divided into cephalic, cervical, dorsal, lumbar and sacral parts.

Cephalic part

- The Cephalic part consists of postganglionic distribution from the superior cervical ganglion.
- The ganglion is situated below the wing of atlas and is an elongated reddish fusiform body.
- The preganglionic fibres arise from the first four thoracic segments of a spinal cord and reach the ganglion by the cervical sympathetic trunk.
- The postganglionic fibres from this ganglion supply gray rami to first cervical spinal and last four cranial nerves and branches also accompany common carotid artery and its branches to supply the structures of the head.

Cervical part

- The cervical part of the sympathetic system consists of the superior and inferior cervical ganglia, connected by an intervening cord on either side.
- The superior cervical ganglion is connected to the last four cranial nerves and first cervical spinal nerve by gray rami. From this ganglion fibres arise which with those of the vagus and glossopharyngeal form a plexus to supply the wall of the pharynx.
- The intermediate cord is the cervical trunk, which passes in close relation to the vagus, runs down the jugular furrow to the thoracic inlet where it separates itself from the vagus and joins the inferior cervical ganglion. The trunk has no connections.
- The inferior cervical ganglion is placed on the internal face of the costal insertion of the scalenus ventralis and against the longus colli.
- It is usually flattened and united with the first thoracic ganglion to form the stellate ganglion. This ganglion receives the cervical trunk and detaches anteriorly the nervous transversarius that accompanies the vertebral artery.
- This nerve passes through the canalis transversarius and detaches at each intervertebral foramen a gray ramus to the cervical spinal nerves from the second to the seventh. Behind, the ganglion detaches a gray ramus to the eighth cervical and the first dorsal spinal nerves.
- It detaches two or three cardiac branches which with the vagus form a cardiac plexus.

Dorsal part

- The dorsal part of the sympathetic system consists of thirteen pairs of ganglia on either side connected by a cord that extends from the inferior cervical ganglion to the first lumbar ganglion. This cord is covered by costal pleura. Each ganglion is connected to the spinal nerve by a gray ramus and a white ramus.
- The first four thoracic ganglia supply
    - Aortic branches
    - Cardiac branches
    - Pulmonary branches and
    - Oesophageal branches
- These unite with the respective fibres of the vagus form plexuses and supply the viscera.
- The great splanchnic nerve is formed by branches arising from thoracic ganglion to the thirteenth spinal nerve.
- It extends alongside the vertebral column in close relation to the dorsal sympathetic trunk, passes backward between the crura of the diaphragm and the psoas minor enters the abdomen and joins the coeliacomesenteric ganglia.
- The lesser splanchnic nerve is represented by fibres from the lumbar ganglion which joins the coeliac ganglion and adrenal plexus.
- The abdominal or lumbar part lies along the internal border of the psoas minor above the aorta and vena cava and presents six lumbar ganglia that are connected by rami communicants to spinal nerves.
- They supply branches to aortic and pelvic plexuses.
- The following are the collateral ganglia
    - Placed on the coeliac axis is the coeliac ganglion and on the anterior mesenteric artery is the anterior mesenteric ganglion.
    - The two ganglia are connected with each other and with those of the opposite side to form a network or plexus around the arteries.
    - The coeliac plexus is on the walls of the coeliac artery and its divisions supply the viscera by passing along the divisions of the artery and by forming subsidiary plexuses as gastric plexus, hepatic plexus, splenic plexus and pancreatic plexus. It also gives branches to aortic plexus.
    - The anterior mesenteric ganglion is on the walls of the artery of the same name and postganglionic fibers from it follow its divisions to supply subsidiary plexuses to the different parts of the intestine, except terminal colon and rectum and kidney.
    - The posterior mesenteric ganglion is an unpaired ganglion.
    - It receives fibers from the anterior mesenteric ganglion, last three or four lumbar ganglia and supplies branches to form secondary plexuses to supply rectum. It also gives branches to renal plexus, spermatic or ovarian plexus and pelvic plexus.
    - The pelvic or sacral part extends along the inferior face of the sacrum and consists of five pairs of ganglia.
    - The pelvic plexuses are formed by branches from the lumbar and sacral ganglia and from posterior mesenteric ganglion. From here secondary plexuses are derived to supply rectum, bladder, uterus, vagina, accessory genital glands and cavernous tissue of penis or clitoris.
    - The sacral parts of the two sympathetic trunks unite behind, below the last sacral segment to form the ganglion impar that is continued by the coccygeal nerve that accompanies the middle coccygeal artery.

PARASYMPATHETIC NERVOUS SYSTEM

- The efferent pathways consist of a cranial and a sacral part.
- The cranial part consists of efferent fibres present in the third, seventh, ninth and tenth cranial nerves.
- The sacral part consists of efferent fibres present in the third, fourth and fifth sacral spinal nerves.

Cranial part

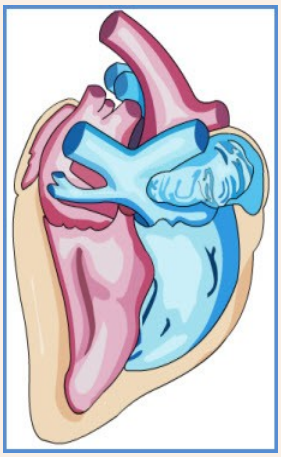
- The oculomotor parasympathetic fibres arise from the Edinger-Westpal nucleus in the midbrain.

- The preganglionic fibres pass along the branch of nerve supplying the inferior oblique muscle and enter the ciliary ganglion.
- This ganglion is small, flattened reddish gray in colour and about the size of a pinhead.
- It is situated near the apex of the orbit in the loose fat between the optic nerve and lateral rectus muscle lying generally on the lateral aspect of the ophthalmic artery.
- The postganglionic fibres leave the ganglion by the short ciliary nerves to be distributed to the ciliary muscle and constrictor pupillae of the iris.
    - The facial nerve contains efferent parasympathetic fibres that arise in the superior salivary nucleus of the medulla oblongata. These pass along the facial nerve then in the chorda tympani and ultimately reach the lingual nerve and enter the mandibular ganglion. The postganglionic fibres leave the ganglion and supply secretomotor fibers to the mandibular and sublingual salivary glands. Some of the parasympathetic fibres that are secretomotor fibres travel in the great superficial petrosal nerve, reach the sphenopalatine ganglion and are relayed to the mucous membrane of nose and palate and to the lacrimal gland via the zygomatic branch of maxillary nerve and the lacrimal nerve. The sphenopalatine ganglion is the largest of the cephalic para sympathetic ganglia and is placed deeply in the pterygopalatine fossa close to the sphenopalatine foramen. It is flattened, reddish-gray in colour and is below the maxillary nerve.
    - The glossopharyngeal nerve contains efferent fibres which arise in the inferior salivary nucleus of the medulla oblongata, travel in this nerve and its tympanic branch, traverse the tympanic plexus, and enter the lesser superficial petrosal nerve and terminate in the otic ganglion. This ganglion is placed immediately below the foramen ovale on the internal face of the mandibular nerve. It is oval, flattened and reddish-gray in colour. From this ganglion the postganglionic fibres are relayed through the superficial temporal nerve and supply secretomotor fibres to the parotid salivary gland.
    - The vagus nerve contains a very large proportion of parasympathetic fibres that arise in the dorsal nucleus of vagus; travel in this nerve and in its oesophageal, pulmonary, cardiac, gastric and intestinal branches. The branches terminate in small ganglia placed in the walls of individual viscera; the postganglionic fibres are relayed finally to the glands and musculature.
    - The cardiac nerve fibres are depressor nerves of the heart and with sympathetic branches form cardiac plexus. The fibres terminate in ganglia placed in the walls of the heart and from here postganglionic fibres are relayed to the substance of the auricles and the auriculoventricular bundle and it is through the latter that ventricle are brought under the action of the vagus.
    - The pulmonary branches are motor to the bronchial muscles and are bronchoconstrictors.
    - The gastric branches are secretomotor to glands and motor to the muscular coat of the walls.
    - The intestinal branches have motor action on the glands of the mucous membrane and muscular wall. The relays are in the Auerbach's and Meissner's plexuses.

Sacral part

- The sacral part of the efferent parasympathetic fibres are contained in the ventral primary divisions of the third, fourth and fifth sacral spinal nerves.
- The visceral branches containing these fibres form a plexus with the sympathetic pelvic plexus.
- Minute parasympathetic ganglia are located in the walls of the viscera and from here the postganglionic fibres are relayed to the organs.
- They supply rectum, urinary bladder, uterus, pelvis and external genitalia. View animation

MODULE-22: ANGIOLOGY



LEARNING OBJECTIVES

- To study about the circulatory apparatus, heart and blood vessels
- To study their structure both gross and microscopic.

INTRODUCTION

- Angiology is that branch of systematic anatomy, which deals with the organs of circulation.
- The circulatory apparatus comprises of heart and vessels.
- The heart is a central hollow muscular organ, which functions as a force and suction pump, situated in the middle mediastinal space of the thorax.
- It is enclosed in a fibro-serous sac-the pericardium.
- The vessels are named blood and lymph vessels according to the nature of fluid they carry.
- This branch of anatomy is divided into two sections, the blood vascular and lymphatic system.

BLOOD VASCULAR SYSTEM

- This system consists of a series of arteries that carry blood into all parts of the body.
- They divide into smaller arterioles, which in turn divide on entering the tissues into minute microscopic tubes, the capillaries.
- The venous capillaries originate from the arterial capillaries and are interposed between the arterial capillaries and the beginning of the veins.
- The veins in turn carry impure blood to the heart.

ARTERIES

- The tubes which convey blood from the heart to various organs are called arteries. These are pulmonary and systemic arteries.
    - Pulmonary artery leaves the heart by a single trunk, subdivides and reaches the lungs. This is called as pulmonary circulation.
    - The systemic arteries originate from the aorta, which arise from the left ventricle and conveys pure blood to all parts of the body.
    - The branches which result from the division of an artery at the termination of its course are named as terminal branches.
    - The branches arising from an artery at varying intervals along its course are called collateral branches.
    - The arteries are surrounded by a layer of connective tissue and may become related to the structures like veins, nerves, muscles, bones and skin.
    - In bone marrow, heart, liver and small blood vessels differ from the capillaries as they are wider with irregular lumen and have no connective tissue covering.
    - Their endothelial cells are in direct contact with cells of the organs and their walls are often incomplete. These vessels are called as sinusoids.

Anastomoses

- Branches of adjacent arteries communicate with each other and form anastomoses.
- When two vessels converge and unite with each other at their termination it is termed as anastomoses by convergence.
- When two branches are directed towards each other and unite to form a single curved tube it is called as anastomoses by arches.
- When the transverse branches connect the two adjacent parallel arteries it is termed as anastomoses by transverse communication.

Histology

- The structure of the artery composed of three coats as tunica intima, tunica media and tunica adventitia.
- The tunica intima is an endothelial lining with delicate layer of connective tissue and internal elastic lamina.
- The tunica media consist of smooth muscle cells with varying amount of collagenous and elastic tissue.
- The tunica adventitia consists of external elastic lamina and connective tissue.

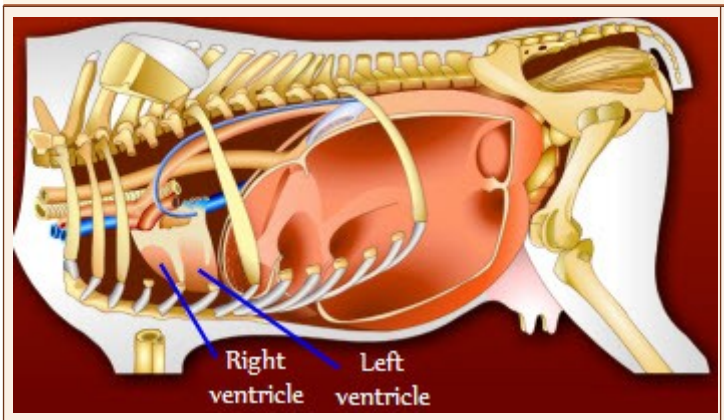
VEINS

- Veins are thin walled structures compared to arteries that carry impure blood to the heart.
- The structure of veins resembles the arteries with few differences.
- The venous wall is composed of all the three layers but much thinner due to the reduction of muscular and elastic tissue components and lack of limiting membrane.
- The veins collapse when empty due the fact that they are thinner.
- Most of the veins excepting the trunk veins are provided with valves. These valves are formed by in folding of the tunica intima.

Blood supply and innervation

- The walls of the arteries and veins are supplied with blood by a large number of small arteries termed vasa vasorum.
- The lymphatics also ramify chiefly in the external coat.
- The nerves accompany the vessels, forming plexus around them and terminate in the muscular layer of the middle coat.

MODULE-23: HEART



LEARNING OBJECTIVES

- The pericardium covering the heart
- The structure of heart and its chambers
- The blood vessel entering and exiting the heart
- The function of heart and its chambers
- The difference in heart structure of various

	domestic animal species.

HEART

- The heart is an involuntary muscular organ which occupies the greater part of the middle mediastinal space.
- Its shape is an irregular and somewhat flattened cone.
- It is attached at the base by the great blood vessels but otherwise it is free in the pericardium.
- It is asymmetrical in position as more of it lies to the left of the median plane. The long axis is directed ventrally and backward.

- The heart presents two surfaces, two borders, a base and an apex.
- The base lies opposite to the lateral wall of thorax from the second intercostal space to the sixth rib.
- The apex lies to the left above the sternum at the sixth interchondral space.
- The anterior border is strongly convex whereas the posterior border is shorter, nearly vertical and is opposite the fifth intercostal space.
- The two surfaces, the right and left are convex and marked by grooves, which indicate the division of the heart into four chambers.
- The coronary or transverse groove indicates the division between the atria and ventricles. It almost completely encircles the heart except at the origin of the pulmonary artery.
- The longitudinal grooves are left anterior and right posterior in position. The left groove begins at the coronary groove behind the origin of the pulmonary artery and descends down almost parallel to the posterior border.
- The right groove begins at the coronary groove below the termination of the posterior vena cava and passes towards the apex but does not reach the apex. There is another intermediate groove, a shallow one that extends from the coronary groove on the wall of the left ventricle but does not reach the apex.
- Coronary vessels and fat occupy the grooves.
- The average weight of the heart in ox is 2.5 kg, i.e. 0.4% -0.5% of body weight.
- The interior of the heart is divided by a complete septum into a right and left halves. Each half is subdivided into an upper atrium and a lower ventricle. The division is indicated externally by grooves.

PERICARDIUM

- The pericardium is a fibro-serous sac which encloses the heart and in part, the great vessels entering and leaving the heart.
- It consists of two layers, fibrous and serous. The fibrous layer is thin but strong and inelastic.
- It is attached above to the great blood vessels at the base of the heart and below by two ligaments- the sterno pericardiac ligaments to the dorsal face of the sternum and an internal sternal ligament between the facets for the 6th costal cartilages.
- The serous layer consists of parietal and visceral part and encloses between them a potential space containing a thin film of serous fluid called the liquor pericardii.
- The parietal part lines the internal face of the fibrous layer to which it is closely adherent. The visceral part covers the heart and is termed the epicardium.

Horse

- The pericardium at the apex of the heart is attached to the middle part of the posterior half of the dorsal face of the sternum.
- The area of contact on the left side extends from the third rib to the sixth intercostal space and on the right from the third intercostal space to the fifth rib.

Dog

- The pericardium is attached to the sternal part of the diaphragm by a fibrous band the pericardiaco-phrenic ligament and is connected to the sternum only by mediastinal pleura.
- The area of contact is chiefly ventral.

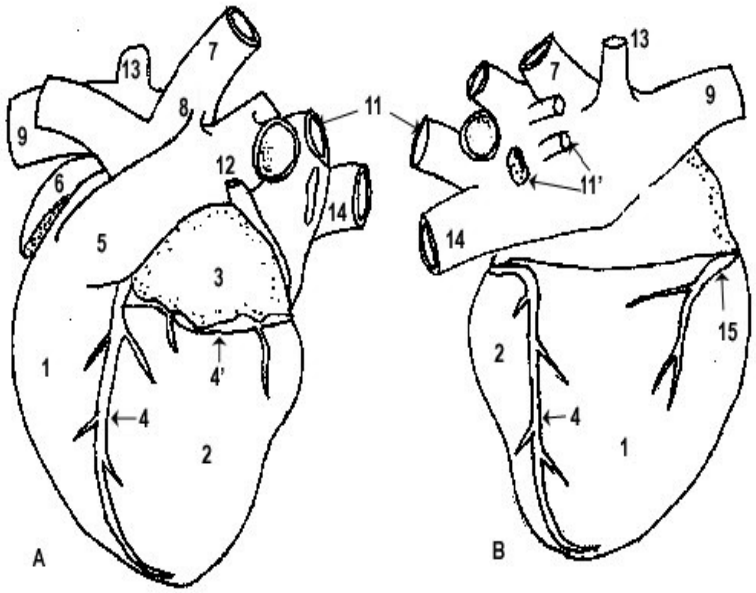
Fowl

- The pericardium is thin and membranous.
- It is related to the lobes of the liver laterally, sternum below and trachea and esophagus dorsally.

CHAMBERS OF HEART

- The heart is divided into four chambers,viz.,
    - Right atrium
    - Right ventricle
    - Left atrium
    - Left ventricle
- The four chambers are externally marked by the transverse grooves and longitudinal groove which are occupied by fat and coronary vessels. (Click here to recollect the different parts of heart)

Bovine heart



Left view (A), Right view (B)

1. Right ventricle
2. Left ventricle
3. Left atrium
4. Left coronary artery
5. Pulmonary artery
6. Right atrium
7. Aorta
8. Ligamentum arteriosum
9. Anterior vena cava

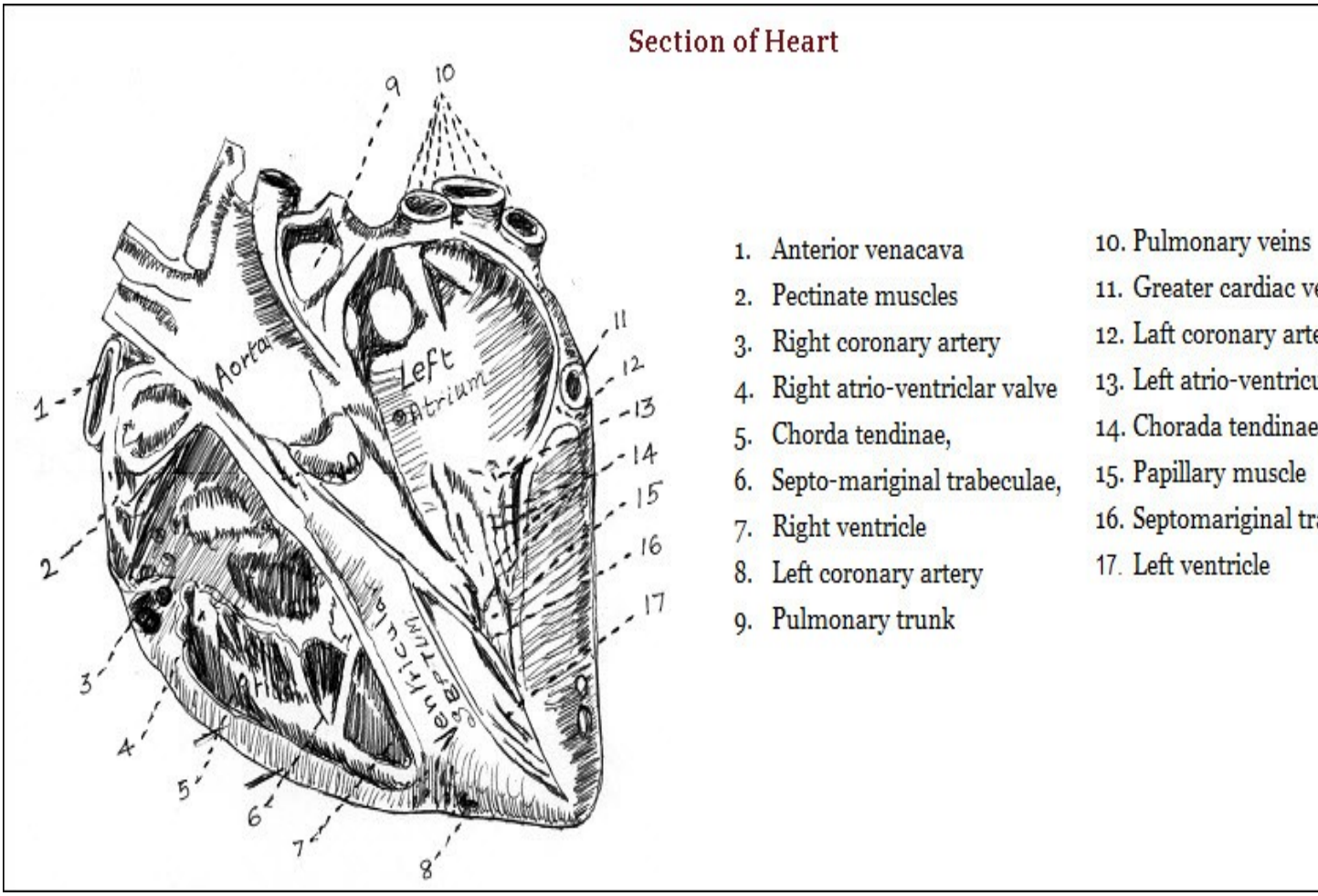
11, 11'. Pulmonary veins

12. Left azygos vein
13. Right azygos vein
14. Posterior vena cava
15. Right coronary artery

RIGHT ATRIUM (RIGHT AURICLE)

- The right atrium forms the right anterior part of the base and is above the right ventricle.
- It consists of a principal cavity called the sinus venarum and a blind diverticulum called the auricle or auricular appendix.
- The sinus venarum is the cavity into which the veins open.
- The auricle curves around the anterior face of the aorta and its blind end appears in front of the origin of the pulmonary artery.

- The following features are seen in the interior of the right atrium
- Smooth glistening membrane lining the sinus venarum called the endocardium, which is continuous with that of the ventricle and the blood vessels entering it.
- The opening of the anterior vena cava at the dorso anterior part of the sinus venarum, which returns the blood from the anterior parts of the body.
- The opening of the posterior venacava returning blood from the posterior parts of the body and opening in to the sinus at the dorso-posterior part.
- A ridge called the intravenous crest projecting downwards and forwards from the dorsal wall in front of the opening of the posterior vena cava. This tends to direct the flow of blood from the anterior venacava towards the auriculo-ventricular opening.
- The coronary sinus is the opening of the great cardiac vein and vena hemiazygos into the sinus venarum below the opening of the posterior vena cava. The orifice is provided with a semilunar fold of endocardium the coronary valve.
- The fossa ovalis is an oval depression in the interatrial septum at the point of entrance of the posterior vena cava and is a remnant of the foramen ovale of the foetus.
- The interior of the auricle is not smooth but crossed by muscular ridges the musculi pectinate in various directions. The musculi pectinati terminates above on a curved crest called the crista terminalis, which indicates the junction of the primitive sinus reunions of the embryo with the atrium proper and corresponds to the sulcus terminalis externally.
- The right atrio-ventricular orifice is situated at the lower part of the floor of the sinus venarum.
- Several small orifices of small cardiac veins are concealed in the depressions.



RIGHT VENTRICLE

- The right ventricle forms the anterior part of the ventricular mass and forms the anterior border of the heart. It does not reach the apex of the heart.
- It is triangular in outline and crescentric on cross section.
- It communicates above at the base with the right atrium through the right atrio- ventricular orifice but its left part projects higher forming the conus arteriosus from which the pulmonary artery arises.
- The apex of the right ventricle is two inches above the apex of the heart.
- The septal wall is convex and faces obliquely forward and to the right.

The following features are seen in the interior

- The endocardium.
- The rounded musculo-tendinous cord called as moderator band extending from the interventricular septum to the right lateral wall.
- The number, size and position are usually variable. Generally one large band is noticed. It is supposed to prevent over distension of the right ventricle.
- The wall of the ventricle except in the conus arteriosus bear muscular ridges called trabeculae carneae.
- A variety of these in the form of conical, flattened projections are the musculi papillaris and are three in number in the right ventricle.
- These are continuous at their bases with the walls of the ventricle and at the apices they give attachment to the chordae tendinae which are fibrous cords attached at their other ends to the cusps of the atrio-ventricular valve.
- The right atrio-ventricular orifice is large oval opening guarded by the tricuspid valve made up of three cusps. Of these, one is between the ventricular orifice and the conus arteriosus; other is against the ventricular septum and another on the right margin.
- The peripheral edges of the cusps are attached to the fibrous ring of the atrio-ventricular opening and the central edges hang down into the ventricle and give attachment to the chordae tendinae. The auricular surfaces of the cusps are smooth and the ventricular surfaces are rough and furnish attachment to the chordae tendinae.
- The valves are folds of endocardium strengthened by fibrous tissue and having muscular tissue at the periphery.
- Each cusp receives chordae tendinae from two papillary muscles. Of the latter, two are on the septum and the third and the largest springs from the anterior wall.
- The pulmonary orifice is circular and is situated at the summit of the conus arteriosus.
- It is guarded by the pulmonary valve composed of three semilunar cusps, one medial (anterior), one lateral (anterior) and the third is posterior.
- The cusps are very thin and almost transparent. Each segment has two borders and two surfaces.
- The attached borders are thick.
- The free borders are concave, thin and nearly straight when tensed. This border of each cusp sometime presents at its middles a small fibrocartilagenous thickening, the corpus Aurantii. The superior surface is concave raised and laid against the walls of the vessel when the ventricle contracts.
- The inferior or ventricular surface is convex which is directed towards the blood when the ventricle contracts.
- A crest-the crista supraventricularis separates cavity of the conus arteriosus from the atrio-ventricular orifice.

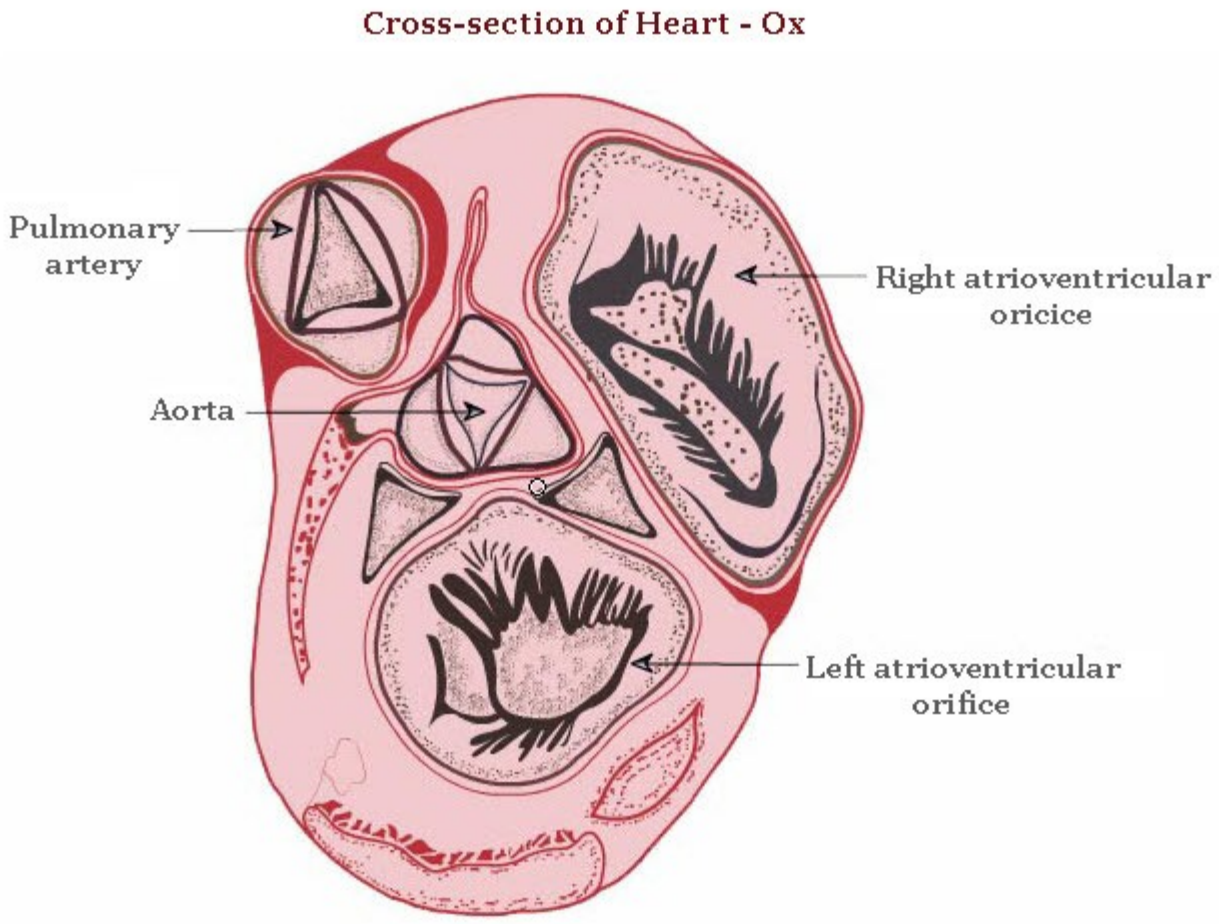
LEFT ATRIUM

- The left atrium forms the posterior part of the base of the heart.
- It lies behind the pulmonary artery and aorta and above the ventricle.
- It consists of a sinus and an auricle.
- The later extends on the left side and its blind end lies behind the origin of the pulmonary artery.

- The sinus receives the pulmonary veins, about 4 to 7 in number in two groups.
- The following features are seen in the interior
    - The endocardium.
    - The openings of pulmonary veins about 4 to 7 in number into the sinus.
    - The musculi pectinate as in the right auricle.
    - The left atrio-ventricular orifice.

LEFT VENTRICLE

- The left ventricle forms the left posterior part of the ventricular mass.
- It is more regularly conical and its wall is much thicker than the right ventricle.
- It forms the entire posterior contour of the heart and carries the apex of the heart.
- The base is continuous with the left atrium and the aorta.
- It is circular on cross section.
- The cavity appears smaller than that of the right ventricle in the dead animal on account of the great contraction of its wall.



- The following features are seen in the interior,
    - The endocardium.
    - The moderator band commonly two large ones, which are more tendinous and branched.
    - Fewer trabeculae carneae.

- Two large muscular papillaris which are compound and one on either side.
- The chordae tendinae are fewer but larger than those of the right ventricle.
- The left atrio-ventricular opening is guarded by the bicuspid or mitral valve consisting of two cusps, anterior and posterior. Of which, the anterior is between the aortic vestibule and left atrio-ventricular opening. The accessory cusps are two or three in number.
- The aortic opening is guarded by the aortic valve, composed of three semi-lunar cusps, one cusp is anterior and the others right and left posterior in position. In bovines visceral bones named os cordis are present at the base of the aortic ring. Two bones, right and left of which the right os cordis is larger than the left.
- The free edge of each cusp contains a small central nodule of fibrous tissue.
- The interventricular septum is placed obliquely, so that the convex surface faces forward and to the right and bulges into the right ventricle; the concave surface, looks backwards, and to the left and faces into the left ventricle. Hence the right ventricle appears crescentic whereas the left is circular in cross section.

SPECIES DIFFERENCE

Horse

- The base is broader and the length from the base to apex is shorter.
- The long axis is more oblique.
- The anterior border is more strongly convex.
- It weighs about 2.9 kg to 3.1 kg.
- The intermediate groove is absent.
- Instead of os cordis, the aortic ring contains on the right side a plate of cartilage.
- Sometimes a small plate of cartialge is present on the left side.

Dog

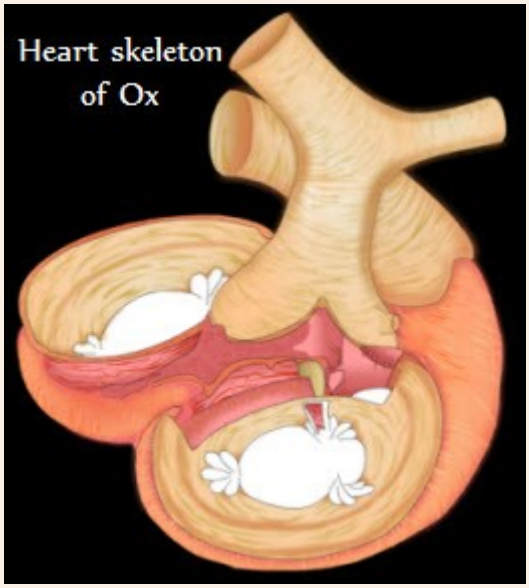
- It is ovoid in shape. The apex is blunt and rounded.
- The long axis is very oblique. The base faces the thoracic inlet.
- The apex is in close relation to the diaphragm at its sternal part.
- The left (ventral) and right (dorsal) longitudinal grooves meet with each other.
- An intermediate groove is present.
- The weight of the heart of a medium sized dog is 150 to 180 gms. The tricuspid valve has two chief cusps and three or four small ones.
- There are four musculi papillaris in the right ventricle, all of which spring from the septal wall.
- The bicuspid valve consists of two large cusps and four or five small ones.
- There are two musculi papillaris in the left ventricle, both of which arise from the lateral wall.

Fowl

- It is proportionately larger.
- It has the form of an acute cone and lies partly between the two lobes of the liver and partly anterior to them.
- The apex is directed backwards and slightly to the left of the median line.
- There are two anterior vena cavae and a single posterior vena cava.
- A muscular fold called the eustachian valve is found to the right of the opening of the posterior vena cava.
- The right atrio ventricular opening is a curved slit and its valve is a muscular leaf, which has neither cusps nor chordae tendinae.

- Musculi papillaris are absent in the right ventricle. The pulmonary artery opening has three semilunar cusps.
- The left atrium is smaller than the right and the two pulmonary veins open into it by a common opening. The left atrio-ventricular valve is guarded by membranous cusps corresponding to the bicuspid valve of mammals.
- The musculi papillaris and chorda tendinae are present in the left ventricle.
- The aortic opening has the three semilunar cusps.

MODULE-24: SKELETAL STRUCTURE AND CONDUCTION SYSTEM OF HEART



LEARNING OBJECTIVES

- To study about fibrous rings, their arrangement and location.
- To study about the bones of heart
- To learn about the musculature of heart, its fibre arrangement etc.
- To study about the structures invovled in conducting of impulses generated in the heart.
- To learn the distribution of neuromuscular fibres.
- It helps to have a better understanding about generation of impulses and its distribution to the heart.
- It helps the clinician to examine the heart and its function and to read echocardiogram.

STRUCTURE OF THE HEART

- The tissues that form the skeleton of the heart are four annular fibrous rings, two small bones, the muscle, serous membrane, vessels and nerves.

Fibrous rings

- The fibrous rings are four in number-two at the atrio-ventricular openings and two at the arterial openings.
- The former separate the muscle fibres of the atria from those of the ventricle.

Bone

- A small bone called the Os cordis (right and left) is found in the aortic ring of old animals.
- The right is larger than the left and is triangular in form. It is related to the attachment of the right posterior cusp of the aortic valve.
- The left is at the junction on the anterior and left posterior cusps.
- They appear to be entirely cartilaginous in young animals.

Musculature

- The myocardium or heart muscle is of a peculiar striated variety arranged in a somewhat complicated manner.
- The muscular tissue of the atria is almost completely separated from that of the ventricles by the fibrous rings around atrio-ventricular orifices.
- The two groups of muscular tissue are however, connected by a bundle of muscle fibres called the atrio-ventricular bundle**.**
- It is a rudimentary structure and pale in colour, which forms part of the conducting system of the heart.
- The fibres of the myocardium fall into two main groups, atrial and ventricular muscle fibres which are independent of each other except for the atrio-ventricular bundle.
- The atrial fibres are of two varieties, superficial or common and deep or special. The superficial fibres are common to both the atria.
- They begin and end in the atrio-ventricular rings, passing transversely across the atria and a few of them dip into the atrial septum.
- The deep fibres are peculiar to each atrium and of two varieties; annular fibres surround the ends of veins, which open into the atria and the fossa ovalis while looped fibres pass over the atria from ring to ring.
- The ventricular fibres are stronger and form two sets. The superficial or common fibres arise from the atrio-ventricular fibrous rings in successive layer and pass in a spiral direction from above downward around the ventricles towards the apex. Here they form a coil bend upon themselves and pass deeply upward to terminate in a papillary muscle of the ventricle opposite to that in which they arose.
- The loop so formed at the apex constitutes a vortex cordis. The deep fibres begins from one side, curve around the wall of the ventricle between the two parts of the superficial set of fibres then pass in the septum to the opposite side and curve around the other ventricle. Thus their arrangement is scroll-like.

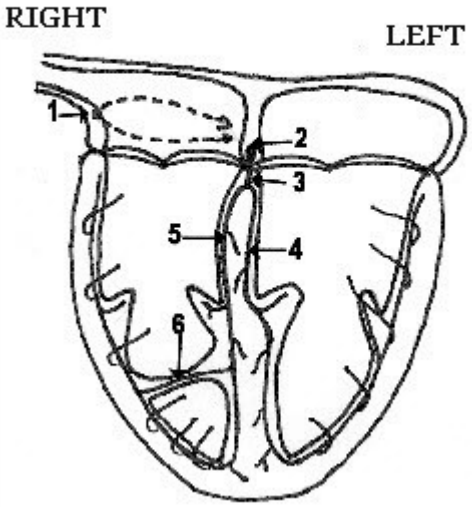
Serous membrane

- The myocardium is covered by the visceral layer of the serous part of the pericardium called the epicardium.
- The cavities of the heart are lined by endocardium.

CONDUCTING SYSTEM OF THE HEART
(Neuromyocardium)

- The parts concerned in the controlling and conducting mechanism of the heart are composed of myocardial tissue distinguished from the ordinary cardiac muscle, not only because it is less highly differentiated from the original cells, but also because the muscle fibres are intimately associated with numerous nerve cells and fibrils which probably have a share in the initiation and transmission of the rhythmic contraction of the heart pace maker.
- Its parts are named the sinu-atrial (SA) node, atrio-ventricular (AV) node, and atrio ventricular (AV) bundle, which end in the terminal subendocardial network.

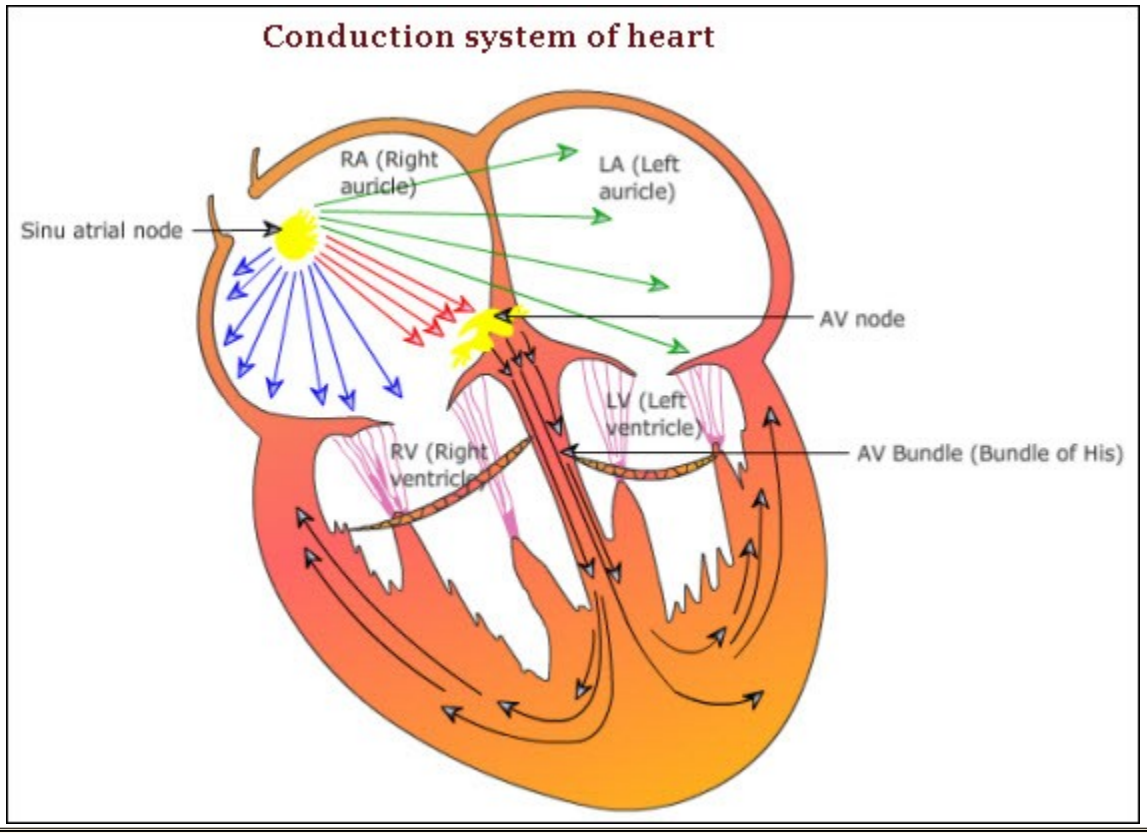
Schematic diagram showing conducting system of Heart



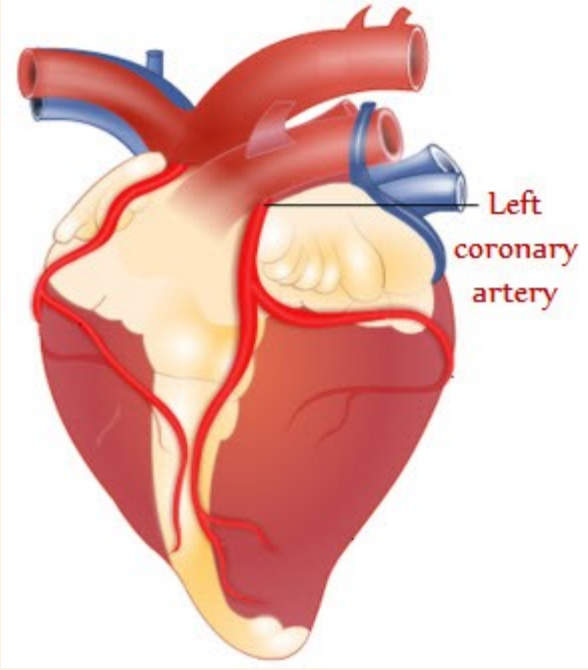
The broken line suggest the passage of the excitation wave through the atrial wall

1. SA node
2. AV node
3. AV bundle
4. Left limb of 3
5. Right limb of 3.
6. Branch of right limb traversing the moderator band.

- The sinu-atrial (SA) node is a small collection of vascular neuromycardium situated in the wall of the right atrium at the upper end of crista terminalis.
- The atrio ventricular (AV) node is a nodule of the same kind of vascular tissue, situated in the septal wall of the atrium immediately above the opening of the coronary sinus.
- The atrio-ventricular (AV) bundle is a pale bundle of the special muscle fibres with which the nerve fibres are associated.
- It springs from the node, runs forward on the septum and reaches the upper border of the ventricular septum. From here it continues as two chief divisions.
- One of these descends on the right side of the ventricular septum and passes by the moderator band to the lateral papillary muscle.
- The other branch descends on the left side of the septum and ramifies on the wall of the ventricle, through the bases of the papillary muscles.
- The bundle and its branches are surrounded by a fibrous sheath and are subendocardial**.**
- The terminal subendocardial network is spread out beneath the endocardium of the greater part of both the ventricles.
- It is derived from the branches of the artio-ventricular bundle at the bases of the papillary muscles.



MODULE-25: PULMONARY AND SYSTEMIC CIRCULATION



LEARNING OBJECTIVES

- To study about the blood vessels carrying blood to the lungs from the heart for oxygenation
- To learn about the circulation of blood through the pulmonary vessels and draining back to the heart
- It helps in understanding the oxygenation of the blood by the lungs and about gas barrier
- To study about the branching pattern of aorta inside the thorax and abdomen
- To understand the distribution of blood to various parts of the body, visceral organs in body cavities from the aorta and its collateral branches
- It helps the surgeon in guiding various surgical approaches by avoiding vascular damage.

PULMONARY ARTERY

- The pulmonary artery springs from the right ventricle at the conus arteriosus.
- It curves upward, backwards and medially and divides behind the aortic arch into right and left pulmonary arteries**.**
- It is related in front to the right atrium and behind to the left atrium and medially to the aorta.
- It is enclosed along with the latter in a common sheath of the visceral part of the serous pericardium.
- Near its termination divides into two branches, it is connected to the aorta by the ligamentum arteriosus, the remnant of the fetal ductus arteriosus.
- The right pulmonary artery is a little longer than left.
- It passes under the bifurcation of the trachea to the hilus of the lung and inside the latter accompanies the bronchial tree on its ventrolateral surface.
- The left pulmonary artery passes backwards under the left bronchial lymph gland and enters the root of the left lung below the left bronchus.

PULMONARY VEINS

- The pulmonary veins are usually 4 to 7 in number and are devoid of valves.
- The capillaries arise from plexus around the alveoli of the lungs, unite to form larger branches accompanying the arterial branches on the ventral face of the bronchioles and finally form the pulmonary veins which open into the left atrium.

AORTA

- The common aorta or aortic trunk is the main systemic arterial trunk. It begins at the base of the left ventricle passes backwards and forwards between the pulmonary artery on the left and right atrium on the right (first part-ascending aorta), turns upwards and backwards inclining slightly to the left, thus describing a curve called the aortic arch with its convexity directed upwards and forwards. At its origin, the caliber is greatest forming the bulbus aortae and here it presents three dilatations, the sinuses of the aorta correspond to the cusps of the aortic valve.
- The aorta then reaches the level of the body of the seventh or eighth dorsal vertebra runs backwards as the thoracic aorta between the lungs below the bodies of the dorsal vertebrae it lies slightly to the left of the median line, and reaches the hiatus aorticus.
- It gradually diminishes in size still about the seventh or eighth dorsal vertebra but thereafter it rapidly diminishes in caliber.
- Passing through the hiatus aorticus it enters the abdomen as the abdominal aorta, passes backwards below the bodies of the lumbar vertebrae and the psoas minor in contact with the left crus of the diaphragm and the ventral longitudinal ligament. About the fifth lumbar vertebra, it terminates by dividing into two internal iliac arteries.
- In addition to its terminal branches, the common aorta gives off two collateral branches, the coronary or cardiac arteries.

Relations

- At its origin the aorta is related to the pulmonary artery on the left at the aortic arch. The thoracic aorta is related on its left to the lung, left pulmonary artery, left vagus and vena hemiazygos and on its right to the oesophagus and trachea.
- In the posterior mediastinum it is related to the lungs laterally and the bodies of dorsal vertebrae dorsally.
- The abdominal aorta is related dorsally to the bodies of lumbar vertebrae, ventral longitudinal ligament, tendon of left crus of diaphragm and psoas minor and ventrally to the pancreas and rumen; on its right to posterior vena cava and on its left to the left adrenal, left kidney and left ureter.

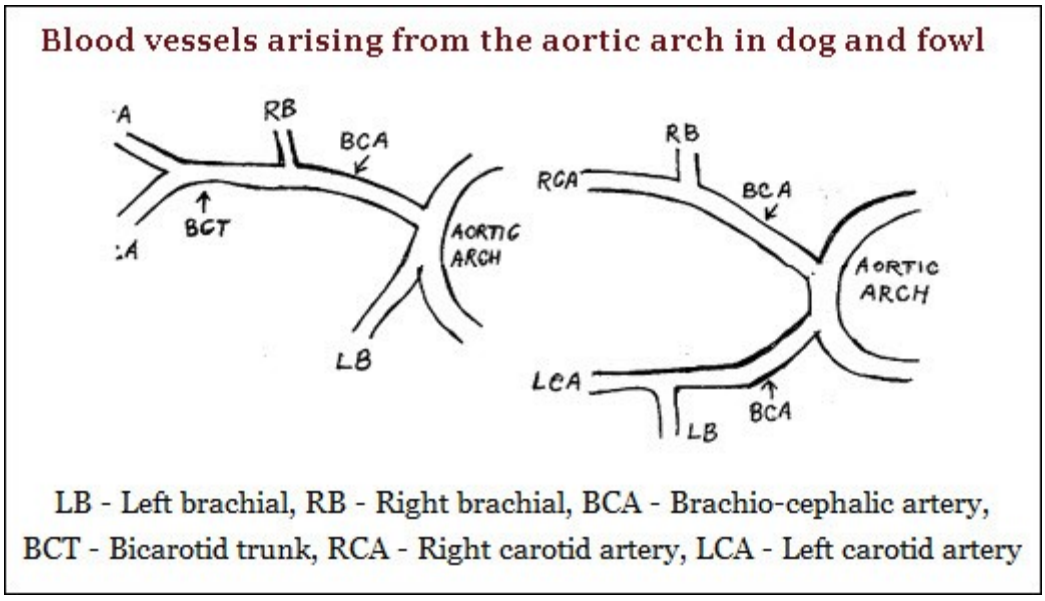
Collateral branches

- The aorta gives number of branches in its course as it run backwards through the thoracic and abdominal cavities; it is convenient to group them into two sets, branches of the thoracic aorta and abdominal aorta. The branches again divide into parietal and visceral.
- The parietal branches are distributed to the walls of the cavities, while the visceral ones are distributed to the organs contained in them. Some of these branches such as intercostals, lumbars, renals, spermatics (in the male) and utero-ovarian (in the female) are in pairs.
- The others are bronchial, oesophageal, phrenic, coeliac, anterior mesenteric, posterior mesenteric and sacro coccygeal arteries are unpaired.

COMMON BRACHIOCEPHALIC TRUNK

- This is a large vessel arising from the convexity of the aortic arch within the pericardium.
- It is directed upwards and forward and it measures about 10 to 13 cm.
- It is between the two layers of the anterior mediastinum and crossed on the left by the left vagus and cardiac nerves and on the right is covered by the anterior vena cava. The left recurrent laryngeal nerve runs between it and the trachea.

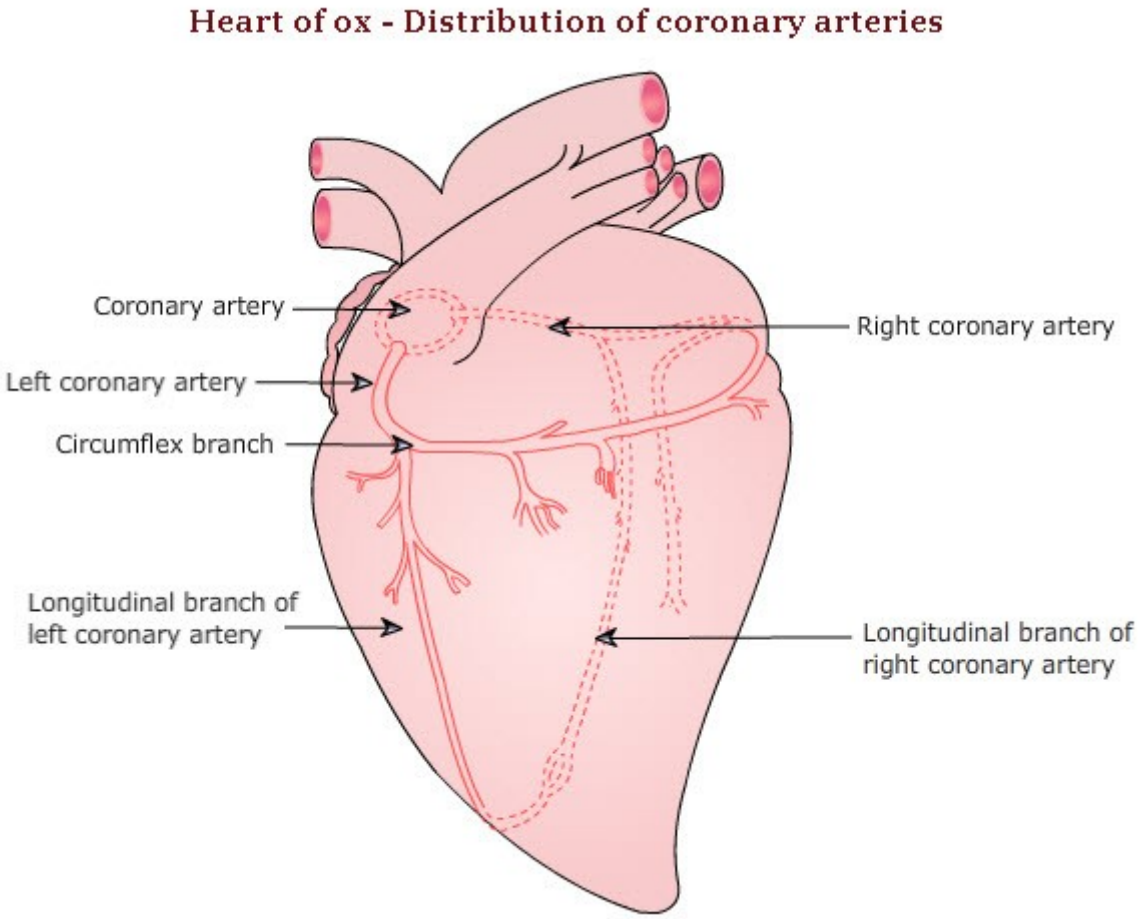
- It divides opposite to the second intercostal space of the third rib into brachiocephalic and left brachial arteries.
- The brachiocephalic artery is directed forwards and upwards beneath the trachea.
- Opposite to the first rib it gives off the right brachial artery and is continued as the bicarotid trunk.
- The bicarotid trunk divides into two common carotid arteries, right and left.



CORONARY/CARDIAC ARTERIES

- The coronary arteries are right and left.
- The right coronary artery is small and it arises from the anterior sinus of the aorta.
- It then passes forwards and somewhat downward to the right between the conus arteriosus and the right atrium to the right coronary groove in which it curves around to the right and backwards to anastomose with the left coronary artery at the origin of the right longitudinal groove.
- The left coronary artery is larger and it arises from the left posterior sinus of the aorta, emerges behind the origin of the pulmonary artery and it divides into two branches.

- It gives off in its course dorsal and ventral branches to wall of the aorta, emerges behind the origin of the pulmonary artery and divides into two branches.
- The descending branch passes down the left longitudinal groove towards the apex, supplying branches to both the ventricular walls.
- The circumflex branch runs backwards in the coronary groove, gives off a branch which descends in the intermediate groove, curves to right and descends into the right longitudinal groove. It supplies branches to the atria, ventricles and the origin of the great blood vessels.

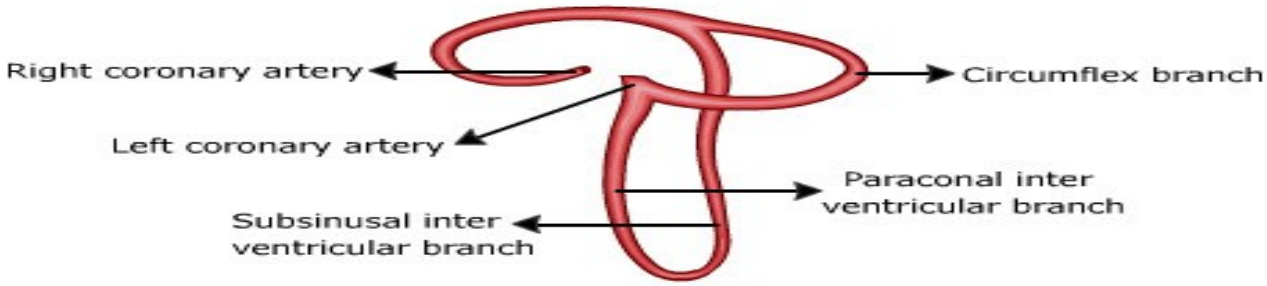


- The venous blood from the myocardium is returned largely through two large veins the right and left ascending coronary veins. These accompany the descending branches of the left coronary artery. The right vein is smaller and it joins the left coronary vein to form the great cardiac vein, which joins the vena hemiazygos and opens into the coronary sinus or the right atrium.
- The right coronary artery has no satellite vein. Small venules open directly into the right atrium between the musculi pectinati. (View image)

Horse and dog

- The right coronary artery is larger than in the ox and it divides into circumflex descending branches.
- The latter passes in the right longitudinal groove.

Coronary circulati



BRONCHIAL ARTERY

- Visceral unpaired. It is the nutrient artery of the lungs.
- It arises from the inferior face of the aorta, descends across the left face of the oesophagus where it divides into right and left bronchial arteries of which the right is larger.
- Each artery reaches the root of the corresponding lung enters the organ, detaches small branches to the bronchial lymph glands, passes on the dorsal face of the bronchi and accompanies its ramifications.

OESOPHAGEAL ARTERY

- Visceral unpaired.
- It arises from the inferior face of the thoracic aorta and passes downwards and divides into branches to supply the thoracic part of the oesophagus, posterior mediastinal lymph gland and lungs.

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INTERCOSTAL ARTERIES

Intercostal arteries

- Of the 13 pairs of intercostal arteries, the first intercostal arises form dorsal artery.
- The second to fifth pair form the sub costal artery and the rest from the thoracic aorta.
- These aortic intercostal arteries arise in pairs from the dorsal face of the thoracic aorta at regular intervals.
- Their origins (of each pair) are close together and they diverge as they pass upwards across the bodies of the dorsal vertebrae and dorsal sympathetic trunk. They cross the vena hemiazygos on the left.
- On gaining the upper part of the corresponding intercostal space each intercostal artery gives off branches to the pleura and vertebra and divides into a dorsospinal and an intercostal branch.
- The dorsospinal branch divides into spinal and muscular branches, the former to reinforce the inferior spinal artery and the latter to supply the spinal muscles.

- The intercostal branch is at first subpleural runs between external and internal muscles, to about the middle of the intercostal space reaches the posterior border of the rib and runs down in company with the nerve and vein to the ventral part.
- It furnishes branches in its course to the intercostal muscles and furnishes some branches, which perforate the intercostal space and pass out as perforating intercostal arteries to supply serratus thoracis and abdominal muscles and skin.
- The terminal branches of each intercostal branch anastomose with the ascending branches of the internal thoracic and musculophrenic arteries.

Phrenic arteries

- Parietal unpaired. There are two or three branches that arise either directly from the thoracic aorta, a little in front of the hiatus aorticus or from the coeliac artery, left ruminal artery, intercostal or lumber arteries and these supply the crura of the diaphragm

Collateral branches

- Branches to the trachea and oesophagus.
- The thryo-laryngeal artery is the largest of the collateral branches.
- It arises from the common carotid artery a little in front of the preceding 2" to 3" behind its final division.
- It divides into thyroid and laryngeal branches.
- The thyroid branch enters the anterior extremity of the lateral lobe of the thyroid gland and is distributed to it.
- The laryngeal branch divides into pharyngeal and laryngeal branches of which the former is distributed to the muscles of the pharynx and the latter to the muscles of the larynx.
- The posterior thyroid artery when present enters the posterior extremity of the lateral lobe of the thyroid gland.
- The inferior parotid artery to the parotid salivary gland.
- The posterior meningeal artery, which enters the cranium through the foramen lacerum and contributes to the formation of the rete mirabile cerebri.
- Muscular branches to the ventral muscles of neck.

MODULE-26: COMMON CAROTID ARTERY AND ITS BRANCHES

LEARNING OBJECTIVES

- To study the origin and course of the carotid artery in thorax, neck and head region.
- To study the blood supply to head, neck and anterior thorax.
- To learn carotid sheath structures in the neck, the carotid trifurcation and blood supply to the face.
- To study about Rete mirabile cerebri- a capillary network below the base of brain and also the blood supply to the various parts of brain by circle of Willis.
- It helps the clinician to examine and recored arterial pulse in large animals by palpation of external maxillary artery.
- It gives better understanding for the surgical approches in face by avoiding the vascular damage.

BICAROTID TRUNK AND COMMON CAROTID ARTERY

Bicarotid trunk

- The bicarotid trunk continues the brachiocephalic artery after it detaches the right brachial artery.
- It is directed forwards beneath the trachea above the jugular confluence.
- It is related laterally to the vagus and recurrent laryngeal nerves.
- At the thoracic inlet, it bifurcates into two common carotid arteries-right and left.

Common carotid artery

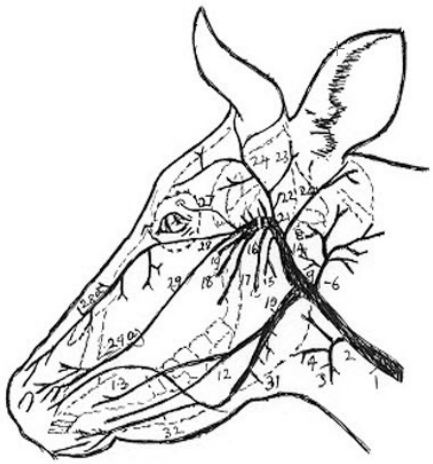
- Each common carotid artery passes up obliquely on the side of the neck and diverges from its fellow as it ascends.
- It crosses the trachea obliquely being at first below then lateral to it and finally on its dorsal face at the termination.

- It is related superficially to the internal jugular vein and the tracheal lymph duct, dorsally to the vagosympathetic trunk and ventrally to the right recurrent laryngeal nerve.
- It is separated from the external jugular vein by the sternomastoideus and omohyoideus.
- It is related in its anterior two thirds to the longus colli, rectus capitis ventralis major and omohyoideus dorsally and to the scalenus laterally at the lower third.
- Each artery is deeply placed at its termination and is related to the parotid and mandibular salivary glands laterally and atlantal lymph glands medially.
- The left common carotid artery has the oesophagus deeply ventral to it in the jugular furrow and the left recurrent laryngeal nerve on this side passes ventral to the oesophagus and between it and the trachea and at its termination it is related to the right common carotid artery.
- The common carotid artery terminates at the level of the digastricus by dividing into occipital, external maxillary and carotid arteries. (Take a view of Carotid trifurcation)

Collateral branches

- Branches to the trachea and oesophagus.
- The thryo-laryngeal artery is the largest of the collateral branches.
- It arises from the common carotid artery a little in front of the preceding 2" to 3" behind its final division.
- It divides into thyroid and laryngeal branches.
- The thyroid branch enters the anterior extremity of the lateral lobe of the thyroid gland and is distributed to it.
- The laryngeal branch divides into pharyngeal and laryngeal branches of which the former is distributed to the muscles of the pharynx and the latter to the muscles of the larynx.
- The posterior thyroid artery when present enters the posterior extremity of the lateral lobe of the thyroid gland.
- The inferior parotid artery to the parotid salivary gland.
- The posterior meningeal artery, which enters the cranium through the foramen lacerum and contributes to the formation of the rete mirabile cerebri.
- Muscular branches to the ventral muscles of neck.

Branches of common carotid artery in ox



1. Common carotid artery
2. Cranial thyroid artery
3. Muscular branch
4. Caudal laryngeal artery
5. Ascending pharyngeal artery
6. Occipital atery
7. Condylar artery
8. Middle meningeal artery
9. Ascending palatine artery
10. Linguofacial trunk
11. Lingual artery
12. Sublingula artery
13. Maxillary labial artery
14. External carotid artery
15. Masseteric branch
16. Mandibulo-alveolar artery
18. Greater palatine artery
19. Spheno-palatine artery
20. Caudal auricular artery
21. Superficial temporal artery
22. Caudal meningeal artery
23. Rostral auricular artery
24. Cornual artery
25. Caudal deep temporal artery
26. Rostral and caudal branches to caudal epidural rete mirabile
27. Supraorbital artery
28. Malar artery
29. Infra labial artery
29a.Anastomotic branch with maxillary labial artery
30. Maxillary artery
31. Facial artery
32. Mandibular labial artery

OCCIPITAL ARTERY

- It is the smallest of the terminal branches of the common carotid artery.
- It passes upwards beneath the wing of atlas and during its course it gives off,
    - Muscular branches to the ventral straight muscles of the head.
    - Branches to the pharynx
    - Palatine branches to the soft palate. It is then continued as the condyloid artery.
    - The condyloid artery passes into the cranium through the anterior foramen in the condyloid fossa and joins the vertebral artery in the formation of rete mirabile cerebri.
    - Before entering the cranium it gives off a branch to the pharyngeal lymph glands and the middle meningeal artery**.**
    - The latter passes through the foramen lacerum. Another branch enters the temporal canal and gives twigs to the temporalis muscle and the mucous membrane of the frontal sinus.
    - A diploic branch goes into the occipital condyle and emits twigs to the occipital muscles.

EXTERNAL MAXILLARY ARTERY

- It arises from the common carotid artery, passes downwards and forwards on the lateral wall of the pharynx in company with the hypoglossal nerve and reaches the ramus of the mandible and turns round the posterior border of the horizontal ramus in company with the external maxillary vein and the Stenson's duct and the ventral buccal nerve. Here it is placed subcutaneously and is useful for feeling the pulse.
- It then ascends the cheek in front of the masseter, passes under the zygomaticus.

Collateral branches

- Pharyngeal and palatine branches to the pharynx and soft palate.
- Branches to the parotid salivary gland.
- The lingual artery is large, runs in company with the glossopharyngeal nerve reaches the anterior extremity of the tongue.
- It supplies branches to the muscles of the tongue and mucous membrane, submaxillary salivary gland it detaches a sublingual artery to the sublingual salivary gland.
- The inferior labial artery is a slender vessel, which passes in company with the ventral buccal nerve along the inferior border of the depressor labii inferioris and it furnishes branches to the buccinator, cutaneous muscle, skin and the lower lip.
- The superior labial artery supplies branches to masseter, zygomaticus, malaris and muscles of the upper lip and cheek and terminates in the nostril.

SUPERFICIAL TEMPORAL ARTERY

- It is the smaller of the two terminal branches of the external carotid artery.
- At first, it passes under cover of the parotid salivary gland, behind the temporomandibular articulation emerges from the deep face of the parotid salivary gland at its anterior part in company with the satellite vein and auriculo-palpebral nerve, runs upwards and backward and reaches the base of the horn core and divides into two branches anterior and posterior to supply the corium of the horn, frontalis and parietoauricularis externus muscles.
- Along its course it gives off,
    - The anterior auricular artery to the muscles of the external ear, temporalis and skin
    - Transverse facial artery which passes over the masseter in company with the vein and nerve and supplies this muscle
    - Palpebral branches to eyelids
    - Lacrimal branches to the lacrimal gland
    - Muscular branches to temporalis and frontalis

- Cutaneous branches to the skin.

INTERNAL MAXILLARY ARTERY

- This is the larger of the two terminal branches of the external carotid artery.
- It passes obliquely forwards and upwards on the lateral aspect of the pharynx and reaches the lower part of the temporal fossa.
- It runs in company with the maxillary nerve to the maxillary hiatus.
- Here, it divides into two sets of branches, the malar and infraorbital and greater palatine and sphenopalatine arteries.

Collateral branches

- Branches to the pterygoid muscles (pterygoid arteries). Parotidotemporal branch arises from the posterior face of the artery and it divides into parotidoauricular and temporomeningeal branches. The former divides into parotid and auricular branches of which the former is distributed to the parotid salivary gland and the latter gains the concave face of the concha and supplies the skin. The temporomeningeal branch enters the temporal canal passes through it detaches a meningeal branch to the duramater and then passes out of the canal into the temporal fossa through one of the foramina and is distributed to the temporalis muscle. This branch is the posterior deep temporal artery.
- Mandibuloalveolar artery arises from the anterior face of the artery passes downwards and forwards over the medial pterygoid on the medial face of the vertical ramus enters the mandibular canal through the inferior maxillary foramen in company with the vein and nerve passes through the canal gains exit at the mental foramen and divides into labial artery to supply the lower lip. At the mental foramen an incisor branch is given off by the inferior dental artery which passes through the incisor canal in the body of the mandible below the roots of the incisors and its branches are distributed to them. Along its course the mandibuloalveolar artery gives off pterygoid branches to the medial pterygoid muscle and dental branches to the lower cheek teeth, the alveolar periosteum and bone.
- The middle meningeal artery arises from the posterior face about the level of the preceding branch passes upwards and backwards gains the company of the mandibular nerve enters the cranium through the foramen ovale and assists in the formation of the rete mirabile cerebri.
- The anterior deep temporal artery arises from the posterior face a little above the preceding gains the anterior part of the temporal fossa enters the deep face of the temporalis muscle and is distributed to it.
- Buccinator artery arises from the anterior face of the artery passes forwards in company with the buccinator nerve. It supplies the pterygoid, masseter and buccinator muscles.
- Anterior meningeal arteries are two or three branches arising from the internal face of the artery pass towards the foramen orbito-rotundum in company with the maxillary nerve enter the cranium and concur in the formation of rete mira bile cerebri. These arteries take the place of the internal carotid of other animals.
- External ophthalmic artery arises from the internal maxillary artery at the level of the temporal fossa. It passes upward crosses the maxillary nerve reaches the orbit penetrates the periorbita passes under the superior rectus and forms a rete mirabile orbitale. It gives off the frontal and nasal arteries. It also gives off in its course lacrimal branch to lacrimal gland, muscular branches to the muscles of the eyeball, ciliary arteries and the central artery of the retina.
- The ciliary arteries arise from the ophthalmic or its muscular branches. They pass between the medial rectus and retractor oculi reach the sclera and divide into anterior and posterior branches. The anterior branches are distributed to the ciliary processes and ciliary muscle. The posterior branches mostly end in the chorioid coat as the short ciliary arteries but branches pass between sclera and chorioid gain the iris, divide and form an arterial circle the circulus iridis major. From this, secondary branches are detached which form a second circle around the pupillary margin, the circulus iridis minor.
- The central artery of the retina is a slender vessel and it supplies the retina.
- The frontal or supraorbital artery passes upwards enters the supraorbital canal gains the frontal sinus and supplies the mucous membrane. The nasal or ethmoidal artery passes backwards gains the cranium through the ethmoidal foramen near the cribriform plate of ethmoid enters the nasal cavity

through one of the large foramina near the crista galli and is distributed to the posterior part of nasal mucous membrane.

TERMINAL BRANCHES

Malar artery

- Malar artery is one of the terminal branches of the internal maxillary artery.
- It runs along the medial wall of the orbit passes along the floor of the orbit penetrates the periorbita gains exit out of the orbit and supplies branches to the lower eyelid and malaris and divides into ascending and descending branches. Of which the former passes up and anastomoses with the branch of the superficial temporal artery and the latter is the dorsal nasal artery to supply the nasal muscles and the nostril.

Infraorbital artery

- Infraorbital artery arises with the malar artery.
- It passes downwards and forwards reaches the maxillary hiatus enters the maxillary foramen passes along the infraorbital canal, passes out of it at the infraorbital foramen and is continued as the lateral nasal artery to supply the nostril.
- In the infraorbital canal it gives off branches to the roots of the upper cheek teeth.

Spheno palatine artery

- Spheno palatine artery arises in common with the greater palatine artery crosses the infraorbital artery enters the sphenopalatine foramen in company with the nerve enters the nasal cavity and divides to supply the nasal mucous membrane.

Greater palatine artery

- Greater palatine artery is the largest of the terminal branches of the internal maxillary artery.
- It enters the palatine canal comes out of it at the anterior palatine foramen passes forwards in the palatine groove on the deep face of the hard palate enters the nasal cavity through the incisive fissure and terminates in the mucous membrane of the anterior part of the nasal cavity.
- In its course it gives off pterygoid branches to the pterygoids posterior branches to the hard palate, nasal branches to the nasal mucous membrane and branches to the dental pad.

EXTERNAL CAROTID ARTERY

- It is the largest of the branches of the common carotid artery.
- It passes forwards and slightly upwards to the posterior border of the styloid cornu and terminates about below the level of the temporo mandibular articulation into superficial temporal and internal maxillary arteries.

Collateral branches

- Pharyngeal branches to pharynx.
- Branches to sub-maxillary salivary gland.
- Branches to parotid salivary gland. (superior parotid artery).
- Posterior auricular artery, which supplies the muscles of the external ear and gives off a stylomastoid branch to the muscles of the middle ear and the tympanic membrane.
- Muscular branches to temporalis, masseter and medial pterygoid muscles.

BLOOD SUPPLY TO BRAIN

- The brain is suppilied by the arterial branches of internal maxillary and external carotid artery which form the Circle of Willis and a capillary network the Rete mirabile cerebri formed by the meningeal branches below the base of the brain.

RETE MIRABILE CEREBRI

- It is a four sided arterial network enclosed in the diaphragma sella around the pituitary gland.
- It is formed by union of the branches of the vertebral, condyloid and meningeal arteries (anterior, middle and posterior).
- The medial branches of the cerebrospinal arteries (branches of vertebral arteries) unite, pass forwards and join the posterior end of the rete.
- The posterolateral angles of the rete mirabile cerebri receive the posterior meningeal arteries.
- Each anterolateral angle receives the anterior meningeal arteries and the middle of each lateral border receives the middle meningeal artery.
- The anastomosis of these arteries gives rise to a vascular network.

CIRCLE OF WILLIS (CIRCULUS ARTERIOSUS)

- From the superior face of the rete mirabile cerebri on either side a single vessel an emergent artery arises.
- It traverses the cavernous sinus penetrates the diaphragm sellae and divides into two primary branches at the base of the brain.
- The anterior primary branch passes forwards crosses the optic tract curves medially and divides into middle and anterior cerebral arteries.
- The middle cerebral artery passes laterally gains the sylvian fissure and divides to supply the lateral aspect of the cerebral hemisphere.
- The anterior cerebral artery passes in front of the optic chiasma gains the great longitudinal fissure and here it is connected to its fellow by a small anastomotic branch thus completing the anterior arc of the circle of Willis.
- It divides to supply the medial aspect of the cerebral hemisphere.
- A small internal ophthalmic artery detached by this vessel crosses the optic nerve and joins the external ophthalmic artery.
- The posterior primary branch passes backwards as the posterior cerebral artery inclines medially detaches the anterior cerebellar artery to the cerebellum and joins its fellow to form the basilar artery thus completing the posterior arc of the circle of Willis.
- This artery passes backwards in the central sulcus on the pons and joins the ventral spinal artery.
- During the course it detaches the posterior cerebellar artery, branches to the pons and medulla and chorioid branches to the chorioid plexus.
- The ventral spinal artery runs along the ventral median fissure of the spinal cord and is reinforced by branches from vertebral intercostal, sacral and coccygeal arteries.

MODULE-27: BRACHIAL ARTERIES

LEARNING OBJECTIVES

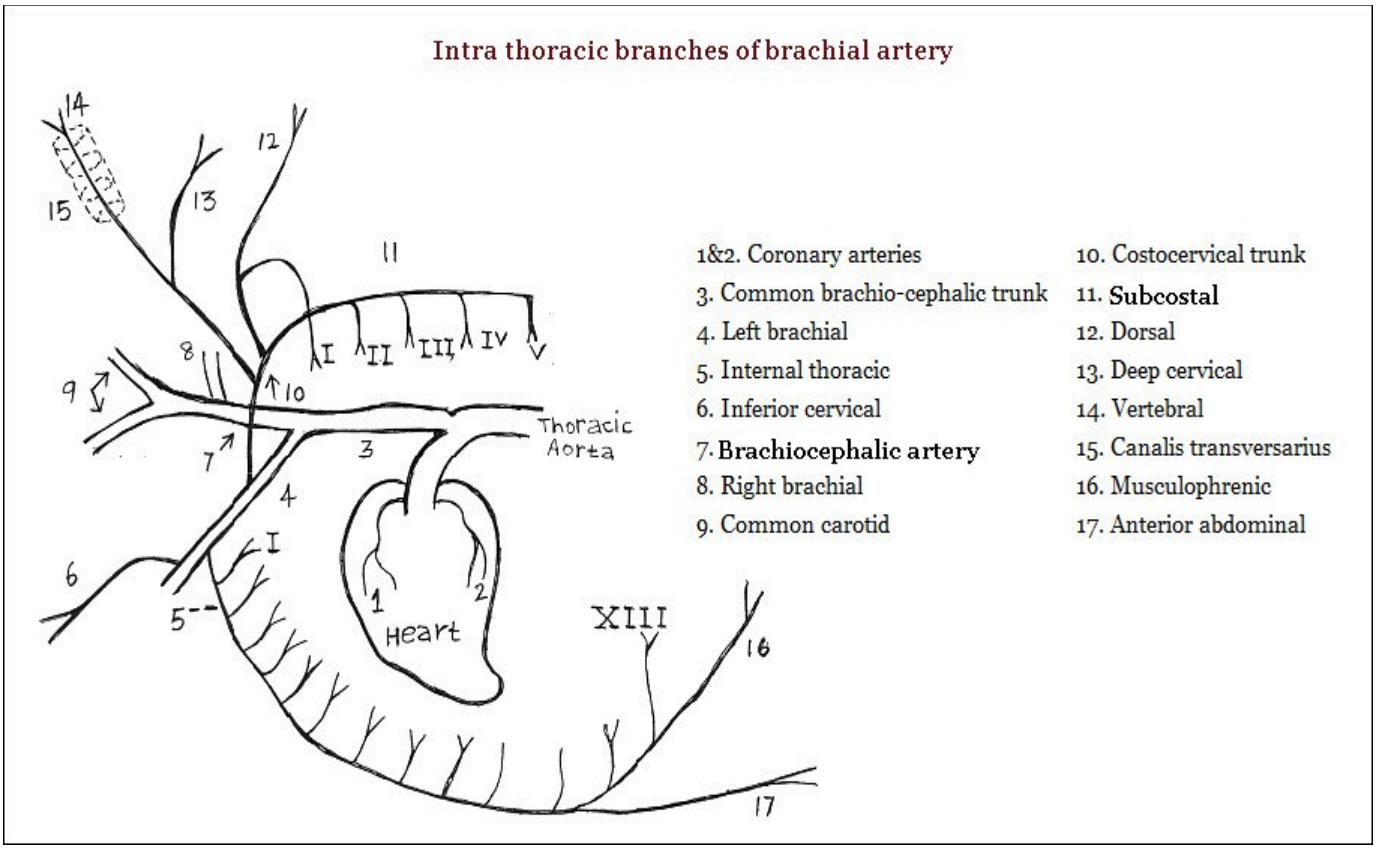
- To study the blood supply to both forelimbs.
- It will help the surgeon to approach the forelim without destrying he major vessels in various surgical procedures.
- It helps the clinician to palpate the median artery therapy in small animals.

BRACHIAL ARTERIES

- The left brachial artery is a branch of the common brachiocephalic trunk while the right is a branch of the brachiocephalic artery.
- Each brachial artery after its origin is directed forwards between the layers of the anterior mediastinum and the trachea towards the thoracic inlet.
- They reach the medial face of the first rib, the left one arising to the side of the trachea and the right passing nearly on the median line and under the trachea to the left and above the anterior vena cava.
- Each artery leaves the thoracic cavity by winding round the anterior border of the first rib below the insertion of scalenus ventralis and above the brachial veins to reach the axilla, thus leaving an impression on the rib.
- It then bends downward, in the axilla. In the midst of the branches of the brachial plexus of nerves, gets included in the loop formed between the musculocutaneous and median nerve on the medial face of shoulder joint, places itself across the subscapularis and turns distally on the medial surface of the arm.
- In the axillary part of the course the artery is related to the serratus thoracis and rectus thoracis, medially.
- It at first curves slightly forwards, then descends in an almost vertical direction crossing the shaft of the humerus obliquely and reaches the lower extremity of the bone, below its medial condyle it is continued as the median artery.
- In its course downwards, it rests successively on teres major, medial head of triceps and the humerus.
- It is related anteriorly to the coracobrachialis above and the biceps below. The median nerve is directly in front and in contact, separating the muscle and this vessel.
- Behind the artery is the brachial vein and further behind is the ulnar nerve. It gives off a number of collateral branches both inside and outside the thoracic cavity.

INTRA THORACIC BRANCHES OF BRACHIAL ARTERY

- A common trunk arises from the dorsal face of the artery close to its origin and soon divides into subcostal, dorsal or costo-cervical, deep or superior cervical and vertebral arteries.



Subcostal artery

- The subcostal artery arises from the dorsal artery or from the common trunk.
- It passes upwards and backwards along the ventral aspect of the bodies of the thoracic vertebrae and gives off the second to the fifth intercostal arteries.

Dorsal artery

- The dorsal artery is small.
- It leaves the thoracic cavity by passing in front of first costotransverse articulation.
- It gives off the first intercostal artery. (View the Distribution of intercostal artery)
- It then passes deeply into the substance of the serratus cervicis and supplies splenius, complexus, rhomboideus, serratus cervicis and trapezius.

Deep cervical artery

- The deep cervical artery arises usually outside the thorax from the superior face of the vertebral artery about the level of the transverse process of the seventh cervical vertebra.
- It passes on the deep face of the complexus and supplies all the muscles of the lateral cervical group, ligamentum nuchae and skin.

Vertebral artery

- The vertebral artery is large.

- They are each on either side. Each emerges out of the thorax between the scalenus and longus colli, passes under transverse process of the seventh cervical vertebra, detaches the superior cervical artery, then enters the foreman transversarium of the sixth cervical vertebra passes through the series of foramina transversarius of the cervical vertebrae with its satellite vein and nerves covered by the intertransversales colli, reaches the intervertebral foramen between the second and the third cervical vertebrae detaches a thick muscular branch and enters the spinal canal.
- It runs forwards on the floor of this canal and divide in the ring of atlas into two branches, medial and lateral.
    - The medial branch or cerebrospinal artery passes on the cranial floor and joins the rete mirabile cerebri a vascular network around the pituitary gland. Several anastomoses with the opposite artery are present.
    - The larger lateral branch contributes a twig to the rete mirabile, emerges out through the intervertebral foramen of atlas and supplies the muscles in this region. The vertebral artery in its course gives branches to the intertransversales colli and opposite to each intervertebral foramen a spinal branch to the spinal cord and its meninges.
    - The spinal branches enter the spinal canal and reinforce the ventral spinal artery on the ventral face of the spinal cord.

INTERNAL THORACIC ARTERY

- This is a large vessel, which arises from the ventral face of the brachial artery opposite the first rib.
- It passes downwards and backwards within the thoracic cavity and terminates into the musculophrenic and anterior abdominal arteries.

Collateral branches

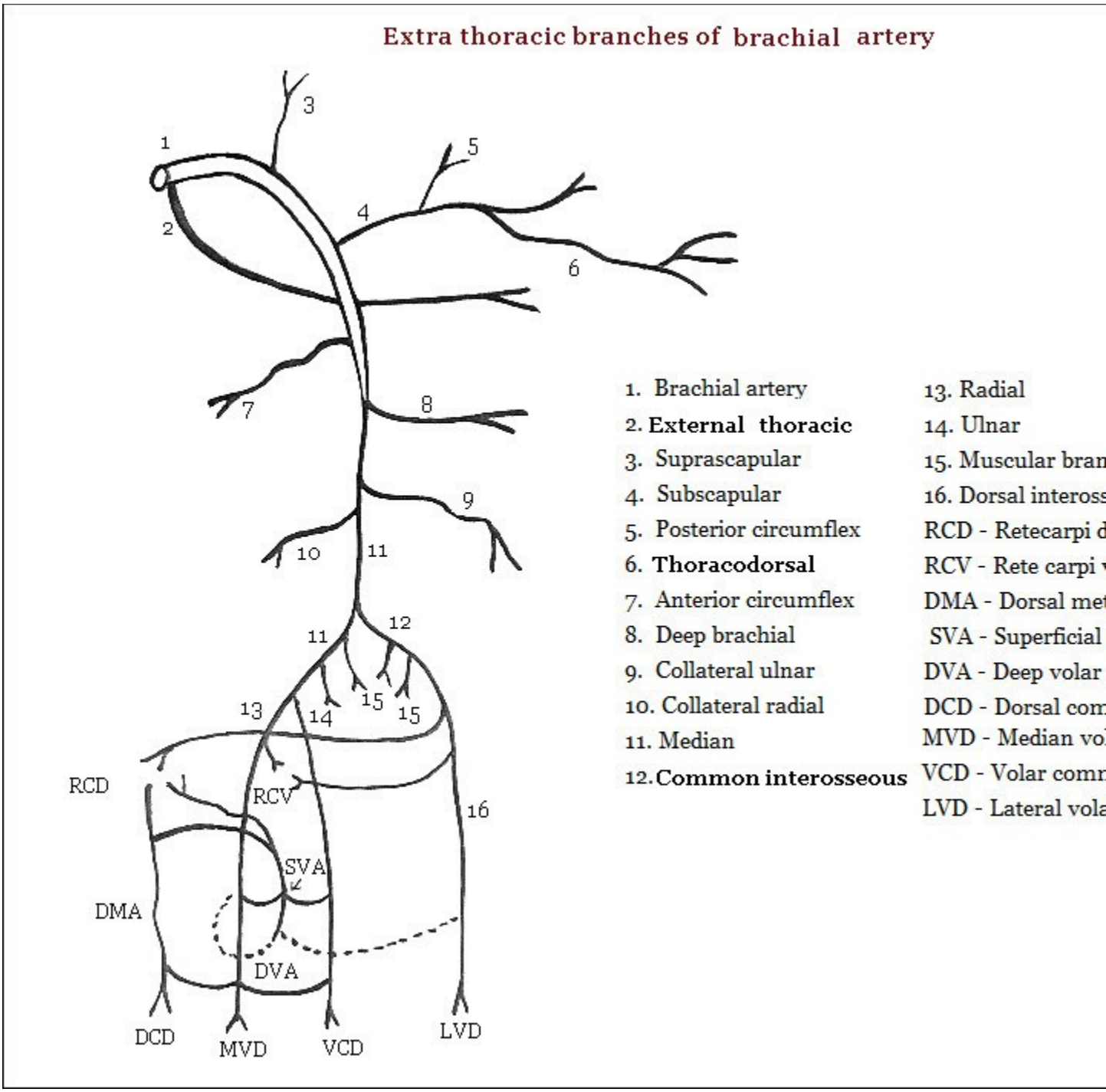
- At each intercostal space it gives off dorsal and ventral branches. The former ascends in the intercostal spaces and anastomoses with the intercostal arteries of the aorta and supply the intercostal muscles.
- The ventral branches gives off small branches to the transversus thoracis, pleura, pericardium and pass out between the costal cartilages as perforating intercostal arteries. These anastomose with the branches of the external thoracic artery and supply pectoral muscles and skin.
- In the young subject, the internal thoracic artery gives off some branches to the thymus.
- The *musculophrenic or asternal artery* passes along the groove between the 8th and 9th costal cartilages and then continues along the costal attachment of the diaphragm and transversus abdominis and gives off muscular branches to the intercostal muscle, transversus abdominis and diaphragm, and anastomoses with the intercostal branches of aorta.
- The *anterior abdominal artery* passes between the nineth costal and xiphoid cartilages, passes backwards on the deep face of the rectus abdominis and supplies this muscle and the ventral wall of the abdomen and anastomoses with the branches of the posterior abdominal artery.

INFERIOR CERVICAL ARTERY

- It arises from the brachial artery at varying levels usually just before it winds round the first rib from its dorsal face.
- It is directed downwards and forward and to the deep face of the brachiocephalicus between it and the omotransversarius.
- It supplies branches to the posterior cervical lymph glands, brachiocephalicus, omotransversarius, prescapular lymph glands, supraspinatus and sometimes the sternocephalicus.

EXTRA THORACIC BRANCHES OF BRACHIAL ARTERY

(Note the Distribution of blood supplying to forelimb)



- Suprascapular artery
- External thoracic artery
- Subscapular artery
    - The thoraco-dorsal artery
    - The posterior circumflex artery of the humerus
    - The circumflex artery of the scapula
- Anterior circumflex artery of the humerus
- Deep brachial artery

- Collateral ulnar artery
- Collateral radial artery
- Median artery
    - Collateral Branches
        - A long muscular branch
        - Common interosseous artery
        - The dorsal interosseous artery
        - The terminal branches
- Radial artery
- The middle deep volar metacarpal artery
- The medial deep volar metacarpal artery
- Ulnar artery
- Dorsal metacarpal artery

SUPRASCAPULAR ARTERY

- It is small and flexuous vessel arising from the upper face of the brachial artery about the middle of its extra thoracic course.
- It ascends and dips in the space between the supraspinatus and subscapularis in company with its satellite vein and suprascapular nerve and divides to supply the subscapularis, supraspinatus, brachiocephalicus and the terminal part of the deep pectoral muscle.

EXTERNAL THORACIC ARTERY

- It is a large vessel arising from the ventral face of the brachial artery at about the level of the anterior border of the first rib.
- It passes backwards on the deep face of the deep pectoral muscle.
- It gives off a number of branches to the pectoral muscles, axillary lymph gland, panniculus and skin.
- One of its branches passes in the groove between the brachiocephalicus and anterior superficial pectoral muscle, supplies them and accompanies the cephalic vein.
- This branch corresponds to the descending branch of the inferior cervical artery of the horse.

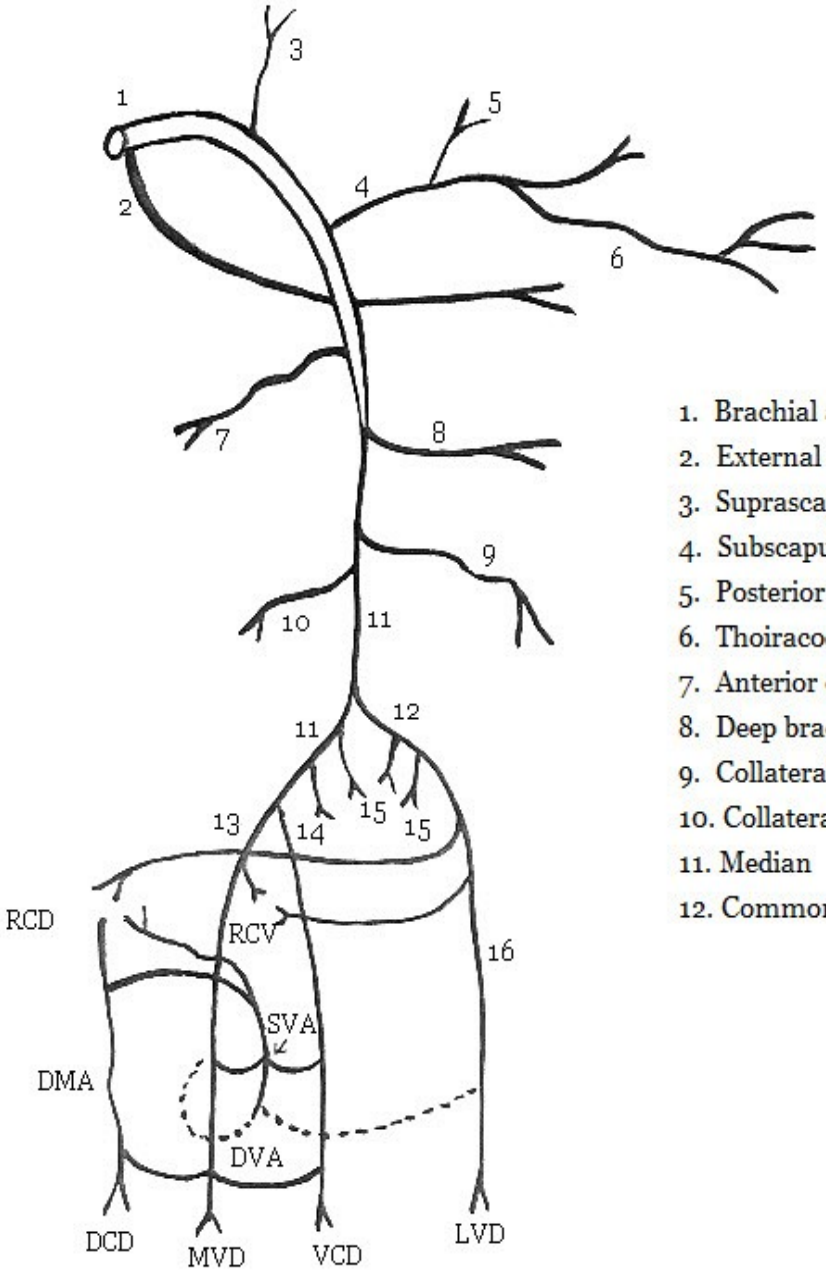
SUBSCAPULAR ARTERY

- It is a very large vessel as large as the brachial artery.
- It arises from the posterior face at the posterior border of the subscapularis muscle.
- It ascends in the space between the subscapularis and teres major along the medial face of the long head of triceps, then along the posterior border of the scapula to about its dorsal angle, turns round the border below this angle and terminates in the infraspinatus and deltoid.
- It supplies in its course branches to the teres major, subscapularis, caput longum, infraspinatus and deltoideus.
- Besides these, the subscapular artery gives off certain named branches such as:

Thoraco-dorsal artery

- The thoraco-dorsal artery is given off from the posterior face of the subscapular artery about an inch above its origin.
- It crosses the teres major, runs upwards and backwards on the deep face of the latissimus dorsi and is distributed to it.
- It also supplies a branch to the caput longum, a branch to the paniculus carnosus and the axillary lymph gland.

Extra thoracic branches of branchial artery



1. Brachial artery
2. External horacic
3. Suprascapular
4. Subscapular
5. Posterior circumflex
6. Thoiracodorsal
7. Anterior circumflex
8. Deep brachial
9. Collateral ulnar
10. Collateral radial
11. Median
12. Common interosseopus
13. Radial
14. Ulnar
15. Muscular branches
16. Dorsal interosseous,

RCD - Retecarpi dorsale
RCV - Rete carpi volare
DMA - Dorsal metacarpal
SVA - Superficial volar arc
DVA - Deep volar arch
DCD - Dorsal common dig
MVD - Median volar digita
VCD - Volar common digit
LVD - Lateral volar digital

Posterior circumflex artery

- The posterior circumflex artery of the humerus arises from the subscapular artery from its anterior face passes downwards behind the shoulder joint in company with the axillary nerve and ramifies on the deep face of the deltoideus.
- It supplies branches to the deltoideus and teres minor and one of its branches accompanies the radial nerve and branches to all heads of triceps, brachialis, anconeus, extensor carpi radialis and cutaneous branch to the skin.

Circumflex artery

- The circumflex artery of the scapula arises from the anterior border of the subscapsularis, 2" or 3" above the shoulder joint.
- It divides into medial and lateral branches, which supply the subscapularis and infraspinatus.

ANTERIOR CIRCUMFLEX ARTERY OF THE HUMEROUS MUSCLE

- This branch arises from the anterior face of the brachial artery at the anterior border of the lower part of teres major and finally terminates in the biceps.
- It supplies the biceps brachii and coracobrachialis.

DEEP BRACHIAL ARTERY

- It is a small vessel arising from the posterior face of the brachial artery about the middle of the humerus.
- It passes backwards between the long and medial heads of triceps, supplies these muscles and tensor fasciae antibrachi.

COLLATERAL ULNAR ARTERY

- This branch arises from the posterior face of the brachial artery and is small.
- It divides into ascending and descending branches to supply caput longum, anconeus, flexor carpi ulnaris and superficial flexor of the digit.
- This branch corresponds to the ulnar artery of the horse and accompanies the ulnar nerve.

COLLATERAL RADIAL ARTERY

- It is a large vessel which arises from the lateral face of the brachial artery at its lower most part, runs outwards and downwards in company with the musculocutaneous branch of the median nerve under the lower part of the biceps and divides into superficial and deep branches.
- The former runs forwards in company with the cutaneous division of the musculocutaneous branch of the median nerve as cutaneous vessel.
- The deep branch gets under the brachialis passes over the capsular ligament of the elbow and passes under the extensor carpi radialis.
- It passes successively under the origin of these extensor muscles and finally terminates in the ulnaris lateralis.
- It supplies all the extensors and the ulnaris lateralis.
- It gives a muscular branch to the biceps at its lower part.

MEDIAN ARTERY

- The median artery is the continuation of the brachial artery below the level of the medial condyle of the humerus.
- It passes along the posteromedial face of the radius and divides at variable distances down the forearm into radial and ulnar arteries.

Collateral branches (View the vascular pattern of the median artery)

- A long muscular branch to supply pronator teres, flexor carpi radialis, flexor carpi ulnaris, superficial and deep flexor of the digit.
- Common interosseous artery: It is a large branch, which arises from the median artery in the upper third of the forearm. It passes through the proximal interosseous space and continues as the dorsal interosseous artery.
- Before it enters the proximal interosseous space, it gives branch to the humeral and radial heads of the deep flexor of the digit; as it passes through the space, it supplies the digital extensor carpi obliques.
- The dorsal interosseous artery runs down the groove between the radius and ulna on the lateral face of the forearm under the periosteum.
- It reaches the level of the distal interosseous space detaches a branch which enters this space continues downward course and concurs in the formation of the rete carpi dorsale.
- The branch detached by it, passes through the distal interosseous space gains the volar face of the forearm gives branches to the rete capi volare and is continued down as the lateral deep volar metacarpal artery.
- This is an extremely fine vessel which passes along the lateral border of the suspensory ligament and by joining the middle deep volar metacarpal and medial deep volar metacarpal arteries forms the deep volar arch above the fetlock, between the bone and the suspensory ligament and is continued as lateral volar digital artery on the lateral digit.

- The terminal branches of the median artery are radial and ulnar artery.

RADIAL ARTERY

- The radial artery is the smaller of the two terminal branches of the median artery.
- It descends along the medio-volar border of the radius under the flexor carpi radialis, passes down subcutaneously over the posterior aspect of the carpus under the deep fascia but out side the carpal canal and is continued down as the medial deep volar metacarpal artery.
- This radial artery gives branches to the formation of the rete carpi dorsale and volare and another branch, which passes between the suspensory ligament and the large metacarpal bone.
- This branch gives off the middle deep volar metacarpal artery and then passes through the foramen at the proximal part of the groove to anastomose with the dorsal metacarpal artery.
    - The middle deep volar metacarpal artery descends down the volar longitudinal groove of the large metacarpal bone and concurs with the branch of medial deep volar metacarpal artery in the formation of the deep volar arch above the fetlock, between the bone and the suspensory ligament.
    - The medial deep volar metacarpal artery passes along the medial border of the suspensory ligament, gives off fine branches to the tendons and suspensory ligament and skin and at the distal third it gives off a branch with which the branches of the volar common digital forms the superficial volar arch and another branch to the deep volar arch. It is continued down as the medial volar digital artery on the medial digit.

ULNAR ARTERY

- The ulnar artery is the larger of the two terminal branches of the median artery.
- It descends under the flexor carpi radialis, passes through the carpal canal on the medial face of tendon of the deep flexor and is continued as the volar common digital artery.
- This vessel passes superficially underneath the deep fascia of the metacarpus along the medial border to the deep flexor tendon in company with the median nerve.
- At the lower third, it gives off a branch to form the superficial volar arch. It then enters the interdigital space and divides into two volar proper digital arteries, one for each digit.
- The nerve accompanies them, pass along the interdigital space of digits.
- Arriving at the foramen near the extensor process of the phalanx, each passes into the foramen, enters the sinus in the interior of the bone and forms an arterial circle from which branches pass to supply the corium of the foot.

DORSAL METACARPAL ARTERY

- It is very small vessel (often absent), which arises from the rete carpi dorsale.
- It passes down the dorsal metacarpal groove and below the fetlock it is joined by the distal perforating metacarpal artery from the deep volar arch to form the volar common digital artery.
- This receives a communicating branch from the volar common digital artery and divides into two dorsal proper digital arteries for the two chief digits.
- These are also accompanied by nerves and they enter the sinuses in the third phalanges and form the arterial circle from which branches pass to the corium of the foot.
- The medial and lateral volar digital arteries descend on the digits and terminate at the bulbs of the heel by anastomosing with corresponding volar proper digital arteries.
- Each gives off a branch to the rudimentary digits and forms a transverse anastomosis behind the first phalanx with the volar common digital or its medial and lateral branches, respectively.

MODULE-28: BRANCHES OF ABDOMINAL AORTA

LEARNING OBJECTIVES

- This lession briefs about the abdominal corta, its course and branches.
- To study the blood supply to abdominal viscera
- It guides the surgeon to avoid large blood vessles in abdominal cavity internal haemorrhage.

BRANCHES OF ABDOMINAL AORTA

- The branches of the abdominal aorta are intended to supply the abdominal walls and the organs in the abdominal cavity.
- Some of them supply to the spinal cord and its meninges, some to the pelvic walls and organs and some to the spermatic cords and scrotum.
- Two of its branches, the external iliac arteries are the main arterial trunks, which supply the structures of the hind limb.

COELIAC AXIS/COELIAC ARTERY

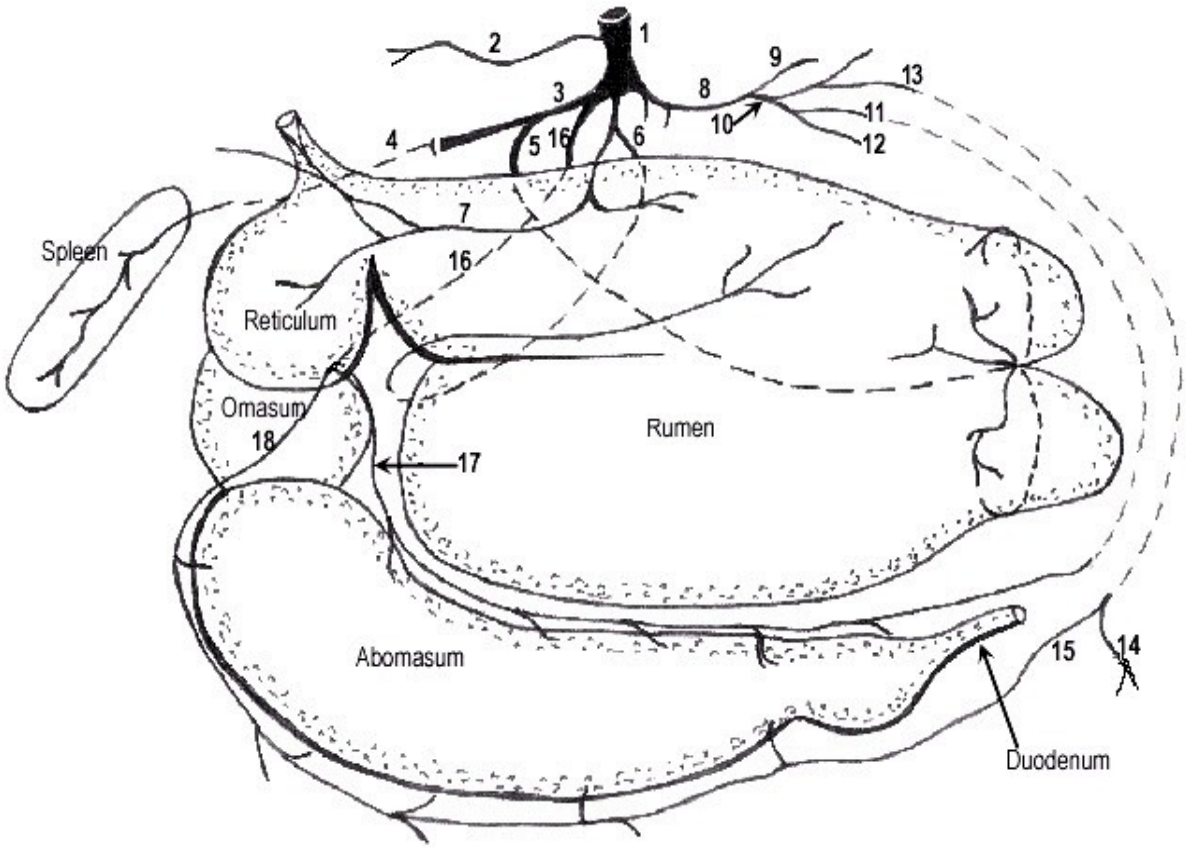
- Visceral unpaired. This artery arises from the ventral face of the abdominal aorta as it enters the abdominal cavity.
- The coeliac ganglia are on the lateral face of the artery and the coeliac plexus enclose the artery along its course.

- It is about 7 to 9 cm long runs downwards on the left face of the rumen turns forward to the right, related to the rumen or pancreas on the left and the right crus of the diaphragm and posterior vena cava on the right and is continued as omaso-abomasal artery.

Collateral branches

- The hepatic artery arises from the coeliac artery as it crosses the posterior vena cava. (View the Blood supply to the liver)
- It passes to the right and somewhat downwards and forwards above the portal vein to the portal fissure and gives off the following branches:
    - Pancreatic branches to the pancreas.
    - Dorsal and ventral hepatic branches to the corresponding lobes of the liver. Of which, the latter is larger and gives off the right gastric artery which runs in the lesser omentum and supplies initial part of duodenum, pylorus and anastomoses with the branches of the dorsal branch of the omaso-abomasal artery (left gastric artery).
    - Cystic branch to gall bladder.
    - The gastroduodenal artery divides into pancreatico-duodenal and right gastroepiploic arteries.
    - The former supplies the pancreas and second part of duodenum and anastomoses with the first intestinal branch of the anterior mesenteric artery.
    - The latter supplies the pylorus and anastomoses with the left gastroepiploic artery (continuation of ventral branch of omaso abomasal artery).

Coeliac artery and its branches in Ox-Semidiagramatic



1. Coeliac artery, 2. Phrenic, 3. Common trunk, 4. Splenic, 5. Right ruminal, 6. Left ruminal, 7. Reticular, 8. Hepatic, 9. Dorsal hepatic branch, 10. Ventral hepatic brancjh, 11. Right gastric artery, 12. Cystic srtery, 13. Gastroduodenal artery, 14. Pancreatico-duodenal 14. Right gastro-epiploic, 16. Omaso-abomasal, 17. Left gastric, 18. Left gastro-epiploic

- The right ruminal artery arises usually by a common trunk with the splenic artery. It forms a sharp curve and runs downward and backward in the right longitudinal groove of rumen giving off numerous branches to it, reaches the posterior transverse groove passes in it reaches the left face of the rumen and anastomoses with the left ruminal artery. It supplies the right face and the posterior one third of the left face of the rumen.
- The left ruminal artery arises from the coeliac artery. It descends at first on the anterior part of the right face of the rumen, enters the anterior transverce groove, passes to the left face of the ruman runs backward in the left longitudinal groove and anastomoses with the branches of the right ruminal artery it supplies the anterior two thirds of the left face of the rumen. Soon after origin, it gives off a reticular artery which supplies to the reticulum.
- The splenic artery arising in common with the right ruminal artery passes forward crosses the dorsal curvature of the rumen reaches the hilus of the spleen and is distributed in it.
- The omaso-abomasal artery is the continuation of the coeliac artery. It is 10 to 13 cm. long passes downwards and forwards to the greater curvature of the omasum and divides into dorsal and ventral branches. The dorsal branch (left gastric artery) passes backwards over the greater curvature of the omasum then along the lesser curvature of the abomasum supplying branches to these compartments

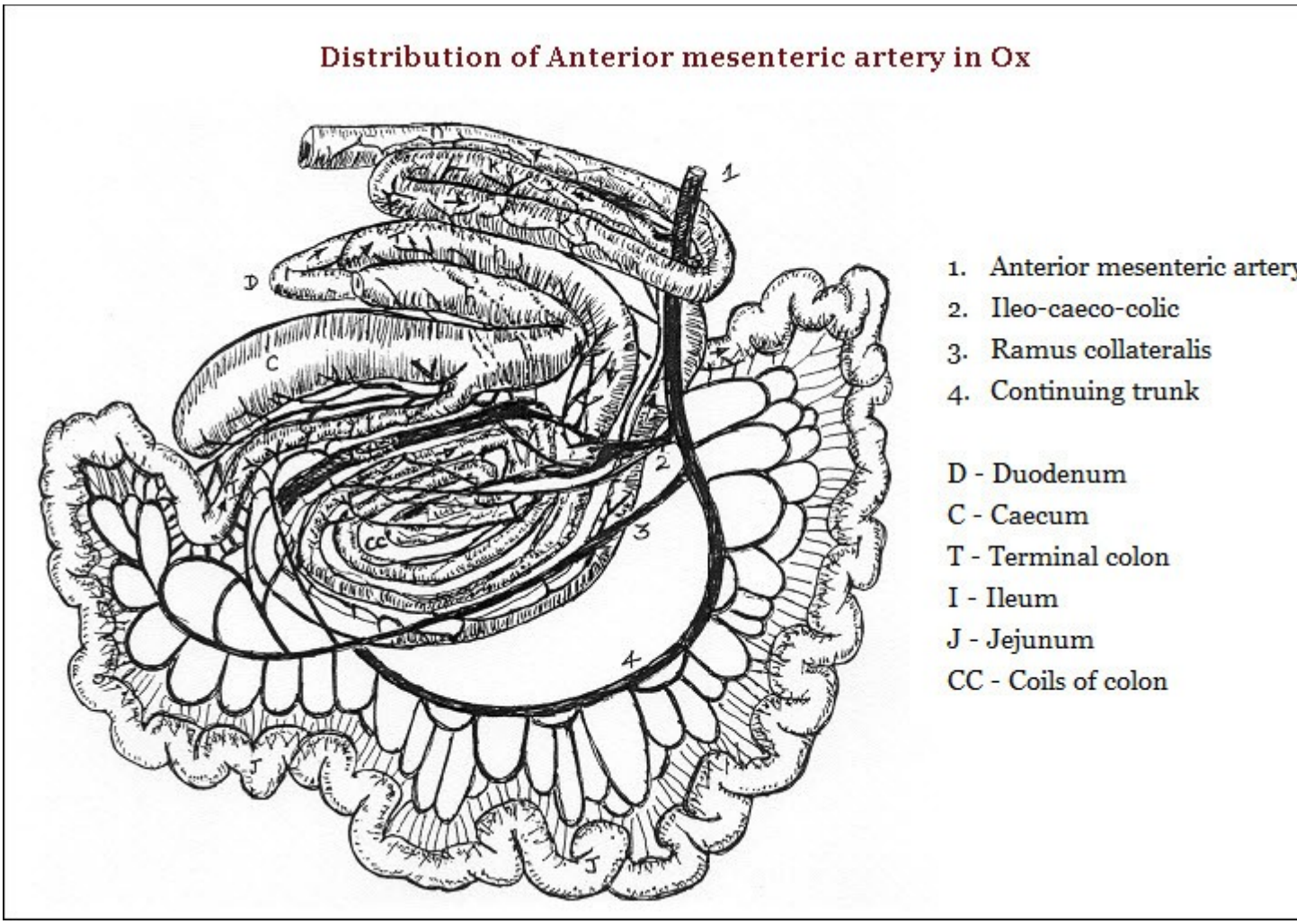
and beyond the pylorus it anastomoses with the right gastric artery. The ventral branch (left gastro epiploic artery) passes downwards and forwards on the lesser curvature of the abomasum giving branches to these compartments and anastomoses with the right gastro epiploic artery.

ANTERIOR MESENTERIC ARTERY

- Visceral unpaired. It arises from the ventral face of the abdominal aorta immediately behind the coeliac artery and is of the same size.
- Its lateral faces are related to the anterior mesenteric ganglia and the mesenteric plexus encloses the artery. (Click to view the Blood circulation of gut)

Collateral branches

- Pancreatic branches to the pancreas.
- The middle colic artery to the terminal part of the colon.
- The ileo colic artery gives off the ileo-caecal artery, which divides into caecal and ileal branches to the caecum and ileum.
- The ramus collaterallis runs in the mesentery along the ventral border of the coils of the colon and unites with the next branch.
- It supplies the posterior one third of the small intestine.
- The continuing trunk passes along the visceral border of the mesentery corresponding to the series of mesenteric lymph glands and unites with the ramus collaterallis.
- It supplies the anterior two-third of the small intestine.
- Both supply branches to the mesenteric lymph glands.



RENAL ARTERIES

(View the Aortic supply in abdomen)

- Visceral paired.
- These are right and left arises close together from the inferior face of the abdominal aorta about 8 cm behind the origin of the preceding branch.
- The right renal artery is shorter but larger while the left renal artery is longer but narrow.
- The right artery enters the hilus of the right kidney.
- The left renal artery passes to the hilus of the left kidney.
- Each renal artery gives off in addition small branches to the ureter, renal lymph gland and adrenal glands.

LUMBAR AND INTERNAL SPERMATIC ARTERIES

Lumbar arteries

- Parietal paired. These arise in series with aortic intercostal arteries and are similar in origin and distribution.

- There are 6 pairs of lumbar arteries. Of which, the first arise from the aorta and sixth arises from the internal iliac artery.
- They arises from the dorsal face of the aorta, pass across the bodies of lumbar vertebrae gain the intertransverse spaces and divides into dorsal and ventral branches.
- The dorsal or lumbo-spinal branches are larger.
- They supply spinal branches to reinforce the ventral spinal artery and muscular branches to supply the muscles of the loins.
- The ventral branches supply the abdominal muscles and skin.

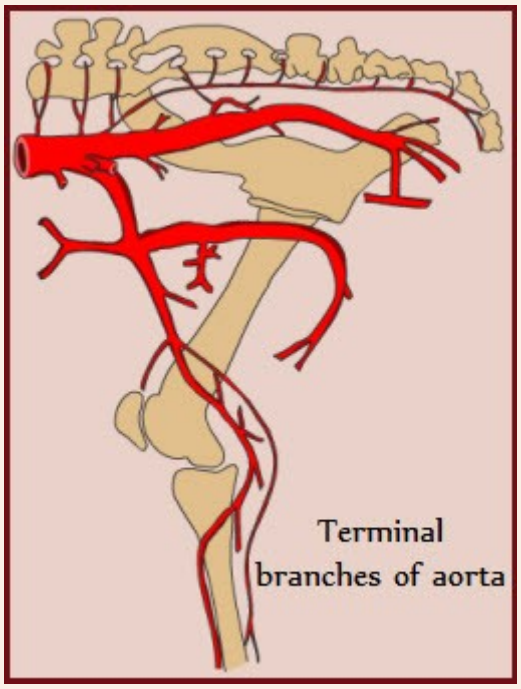
Internal spermatic arteries

- Visceral paired. In the male, these arteries arise from the ventral face of the aorta close together near the posterior mesenteric artery.
- Each very slender and is the longest branch.
- It is at first directed downwards, backwards and outwards reaches the internal inguinal canal as one of the constituent structures of the spermatic cord in its anterior border exhibiting a remarkable tortuous disposition.
- It forms numerous coils surrounded by the pampiniform plexus of veins and closely associated with the spermatic nerves and lymphatics and unstriped muscle fibresl.
- It passes out of the external abdominal ring reaches the head of the epididymis passes along its attached border turns upwards at the ventral extremity of the testicle and passes along its anterior border.
- The branches penetrate the tunica albuginea and supply the parenchyma. Each spermatic artery varies in origin.
- It may arise from the posterior mesenteric or renal or the two may have a common trunk.
- In the female this vessel is the utero-ovarian artery.
- It is slender vessel, which passes backwards in the anterior part of the broad ligament of the uterus and divides into ovarian and anterior uterine branches to the ovary and the horn of the uterus.
- The latter anastomoses with the branches of the middle uterine artery.

POSTERIOR MESENTERIC ARTERY

- Visceral unpaired.
- It arises from the ventral face of the aorta near its termination behind the origin of the spermatic arteries.
- It is related to the posterior mesenteric ganglion and the plexus encloses the vessel.
- It divides in to an anterior short colic branch to supply the terminal part of the colon and a posterior longer anterior haemorrhoidal branch to supply the rectum.

MODULE-29: TERMINAL BRANCHES OF AORTA



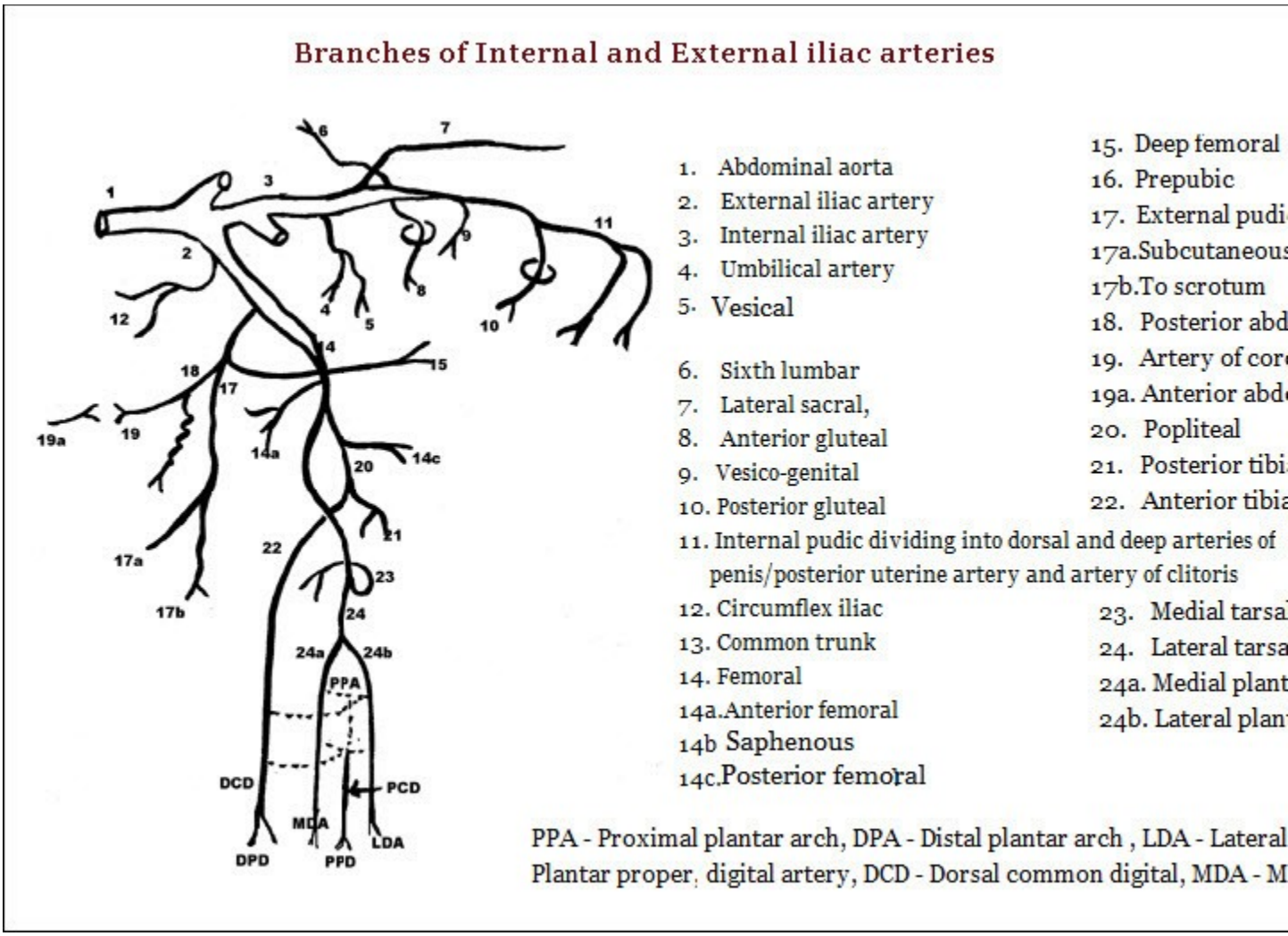
LEARNING OBJECTIVES

- The lesson will teach you about the terminal division of aorta
- It helps in understanding the blood supply to the pelvic wall and its contents.
- It will help the clinician to examine the fremitus in pregnant animals.
- To study the blood supply to the coccygeal region.

EXTERNAL ILIAC ARTERY

- The hind limb is supplied with blood by the external iliac artery.
- Each arises from lateral surface of aorta just in front of the internal iliac artery.
- It passes downward and backward along the tendon of psoas parvus to the side of the pelvic inlet crosses the tendon reaches the anterior border of the pubis, gains the space between sartorius and pectineus and is continued as the femoral artery.
- In its course, it is covered by peritoneum and is related laterally to the tendon of psoas minor, sartorius and iliacus and medially to the common iliac vein, posteriorly to the external iliac vein. (View the Vascular pattern in pelvic cavity)

Collateral Branches



Circumflex iliac artery

- It is a large vessel arising from the external iliac artery close to its origin passes downwards, towards the lateral angle of the ilium supplying branches to psoas major and iliacus and divides into superior and inferior branches.
- The *anterior (superior) branch* runs downwards and forwards on the transverse abdominis then gets under the internal oblique muscle perforates it gets under the external oblique muscle and finally reaches the skin of the flank. It supplies all these muscles and skin.
- The *posterior (inferior) branch* also supplies branches to the iliopsoas, penetrates the abdominal wall descends on the deep face of the tensor fascia late and supplies to these muscles, the prefemoral lymph gland and skin of the thigh.

- A common trunk arises from the anterior face of the external iliac artery and this divides into two branches the prepubic and deep femoral arteries.

Prepubic artery

- Prepubic artery passes forwards from its origin crosses the Poupart's ligament and divides into external pudic and posterior abdominal arteries.
  - The external pudic artery branch supplies chiefly the scrotum in the male**.** It descends on the Poupart's ligament in the inguinal canal at the posterior border of the spermatic cord passes

out of the canal at the external inguinal ring and gives off the subcutaneous abdominal artery and branches to scrotum. The subcutaneous abdominal artery passes forwards on the tunica abdominalis supplies branches to the scrotum, superficial inguinal lymph gland and skin. In the female this vessel is very large and termed the mammary artery, which passes through the inguinal canal and divides into two branches an anterior and a posterior to supply the mammary gland. A small subcutaneous abdominal artery arising from the anterior mammary artery supplies the skin in front of the mammary gland.

- The posterior abdominal artery crosses the spermatic cord supplies branches to the internal oblique muscle runs forwards on the deep face of the rectus abdominis and is distributed to it. Its branches anastomose with those of the anterior abdominal artery. The artery of spermatic cord or cremasteric artery or external spermatic artery is a very small vessel that arises usually from the posterior abdominal artery, passes through the inguinal canal along the posterior border of the cremaster externus, and supplies branches to this muscle, tunica vaginalis and the other structures of the cord. In the female, this branch is represented by a small vessel, which supplies the anterior part of the uterus.

Deep femoral artery

- Deep femoral atery is a large vessel usually arising by a common trunk with the prepubic artery.
- It passes under Poupart's ligament between the iliacus and pectineus muscles.
- Then it divides into two sets of vessels, which supply the biceps femoris and semitendinosus.
- Its supplies in its course branches to pectineus, gracilis obturator externus, adductor semimembranosus, quadratus femoris, biceps femoris, semitendinosus hip joint and obturator internus.

FEMORAL ARTERY

- This is the main arterial trunk of the thigh.

- It continues the external iliac artery below the level of the pubis descends in the femoral canal in company with the vein and saphenous nerve passes underneath the lower part of gracilis over the vastus medialis.
- On the posterior face of the femur, it dips in between the two heads of the gastrocnemius and is continued as the popliteal artery.

Collateral branches

- Anterior femoral artery arises from the anterior face of the femoral artery passes outwards, downward and forwards to supply the four heads of the quadriceps muscle and the articularis genu. Muscular branches to pectineus, sartorius, gracilis, vastus medialis and semimembranosus.
- Saphenous artery is given off about the middle of its course through the femoral canal.
- It becomes superficial by emerging between the lower parts of sartorius and gracilis passes down in company with the saphenous vein and saphenous nerve on the medial face of the leg. On reaching the hollow of the hock, it divides into medial and lateral tarsal arteries.
- It supplies branches to sartorius, gracilis and cutaneous branches of the skin.
    - The lateral tarsal artery is smaller and it passes outwards and contributes towards the formation of the rete tarsi dorsale.
    - The medial tarsal artery passes down in company with the tibial nerve along the deep flexor tendon and divides into medial and lateral plantar arteries.
    - The lateral plantar artery is smaller and it passes down under the deep fascia of the metatarsus and is continued down as the lateral plantar superficial metatarsal artery. This gives a branch to the distal plantar arch and is continued as the lateral digital artery for the lateral digit.
    - The medial plantar artery is larger and it passes down the tarsal sheath along the medial border of the deep flexor tendon passes under the deep fascia of the metatarsus gives off a

branch to the proximal plantar arch and is continued down as the medial plantar superficial metatarsal artery**.** At the lower part this furnishes branches to the distal plantar arch and is continued down as the medial digital artery for the medial digit.

- Posterior femoral artery is a large vessel, which marks the lower limit of the femoral artery.
- It divides into superior and inferior branches and the former ascends between the semimembranosus and biceps femoris and supplies these muscles while the latter accompanies the lateral head of the gastrocnemius and supplies it.

POPLITEAL ARTERY

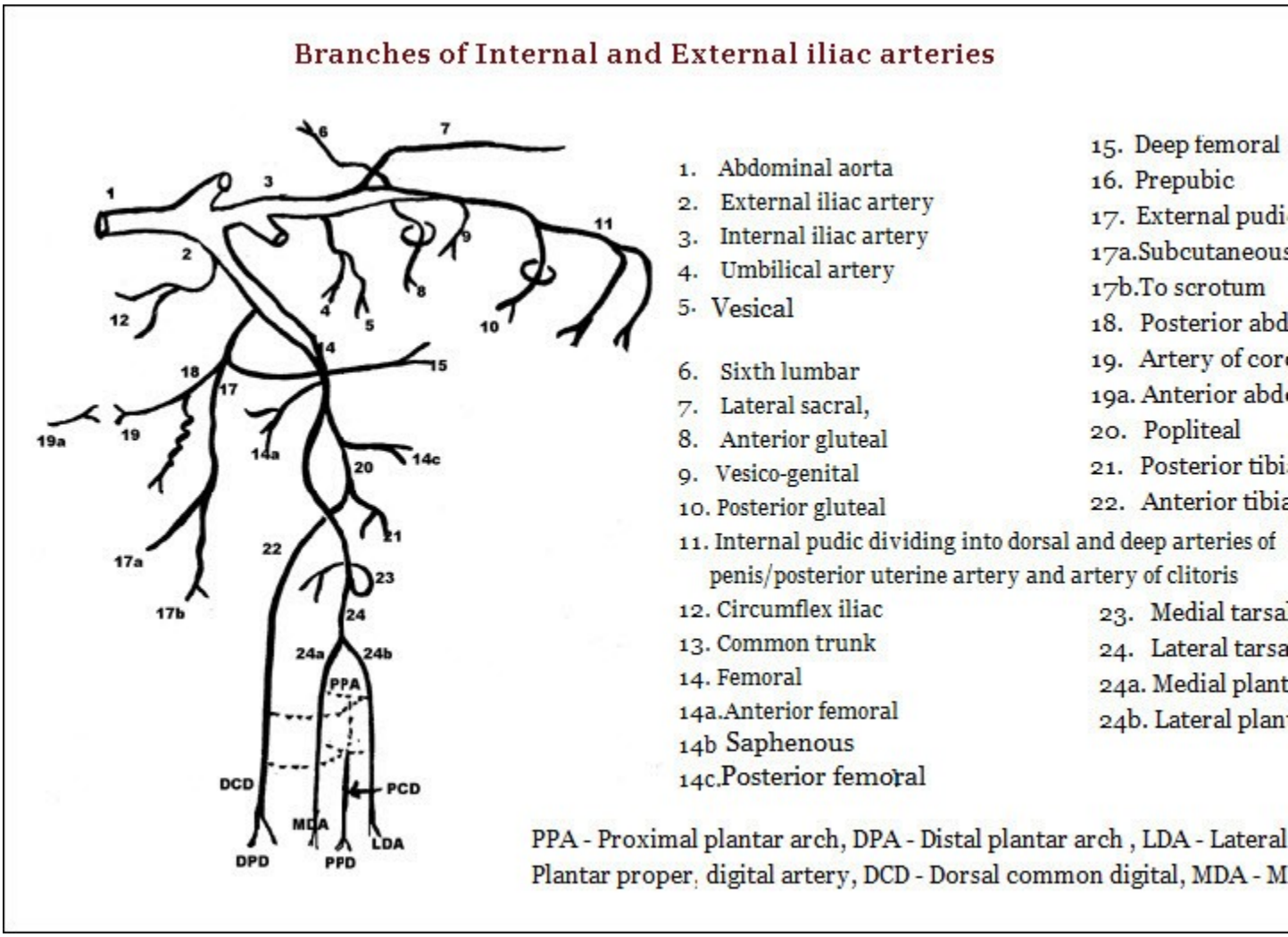
- The vessel is very short and continues the femoral artery over the posterior capsular ligament of the stifle joint detaches the posterior tibial artery and gets under cover of the popliteus muscle and is continued as anterior tibial artery. It furnishes branches to the gastrocnemius and superficial flexor of the digits.
    - Posterior tibial artery is a very slender vessel, which runs down on the posterior face of the popliteus muscle and supplies popliteus and deep flexor of the digits.
    - Anterior tibial artery continues the popliteal artery and runs under the popliteus and deep flexor crosses the upper part of the lateral border of the tibia passes through tibio-fibular arch passes successively under the origins of the lateral digital extensor, peroneus longus and between the muscles and bone. Here it gives off a number of collateral branches to the muscle of the dorsolateral group. It then gains the lateral face of the tibia.
    - It runs downwards on the lateral border of the tibialis anterior and between this muscle and the bone in company with the deep peroneal nerve it runs downwards passes over the anterior ligament of the tarsus and divides into perforating tarsal and dorsal metatarsal arteries.
- The perforating tarsal artery passes backwards through the vascular canal in the tarsal bones reaches the posterior face of the large metatarsal bone and unites with the branches from the medial and lateral plantar arteries to form the proximal plantar arch between the bone and suspensory ligament. From the ventral face of this arch a small deep plantar metatarsal artery descends on the plantar groove of the bone to the distal plantar arch.
- The dorsal metatarsal artery descends in the dorsal metatarsal groove in company with the veins and the deep peroneal nerve gives off branches to the extensor brevis detaches at the lower third, a perforating metatarsal artery which passes to the posterior face of the large metatarsal bone and unites with the branches of the medial and lateral plantar superficial metatarsal arteries to form the distal plantar arch. The dorsal metatarsal artery continues downwards as the dorsal common digital artery, which enters the interdigital space and divides into two branches. These branches unite with the like branches of the plantar common digital artery to form the two proper digital arteries one for each digit.
- The plantar common digital artery arises from distal plantar arch and divides into two branches, which unite with similar branches of the dorsal common digital artery to form the proper digital arteries. It also anastomoses with the abaxial digital arteries.

INTERNAL ILIAC ARTERY
(Hypogastric arteries)

- It is the main arterial trunk, which supplies the pelvic wall and viscera. Each artery passes obliquely downwards and backwards on the sacrosciatic ligament and terminates about the level of the lesser sciatic foramen by dividing into posterior gluteal and internal pudic arteries.

Collateral branches

- A large common trunk, which after giving off a branch to the ureter divides into umbilical and vesical arteries in the male.
- The umbilical artery is usually obliterated in the adult.
- In the fetus it is large and runs in the free margin of the lateral ligament of bladder passes through the umbilicus and ramifies in the placenta carrying impure blood for oxygenation.
- As this artery is no longer required after birth it gradually gets atrophied and the lumen is obliterated.
- The obliterated part of the vessel forms the round ligament of the bladder.
- The vesical artery supplies the urinary bladder.
    - In the female the common trunk divides into umbilical and middle uterine arteries.
    - The former resembles that of the male and the middle uterine artery is of considerable size and supplies the horn and body of the uterus.
    - Its branches anastomose with those of the anterior uterine artery in front and posterior uterine artery behind.



- A short common trunk which divides into
    - the sixth lumbar artery
    - lateral sacral artery if the middle sacral artery is absent
    - anterior gluteal artery which passes out through the greater sacrosciatic foramen and supplies middle gluteus and deep gluteus.

- Vesico-genital artery arises from the ventral face of the internal iliac artery and supplies branches to the bladder, ureter, vas deferens, vesiculae seminalis, prostate and urethra.
- The posterior gluteal artery passes out of the pelvis through the lesser sacrosciatic foramen and supplies biceps femoris and middle gluteus.
- The internal pudic artery continues the internal iliac artery.
- It supplies branches to the bladder, urethra, obturator internus, retractor and compressor coccygeus and cutaneous branches to the skin. It then passes down the ischial arch and in the male; it divides into dorsal and deep arteries of the penis.
- The former runs superficially over the dorsum penis to the glands as the dorsal artery of the penis.
- The deep artery of the penis supplies the corpus cavernosum penis.
- In the female, it gives off a large posterior uterine artery to the uterus and vagina and terminates as the artery of the clitoris. (Locate the branches of internal iliac artery)

SACRAL ARTERY

- The middle sacral artery is the continuation of abdominal aorta after the terminal branches of internal iliac artery and runs under the sacral vertebrae and further continues as the median coccygeal artery.
- If middle sacral artery is absent it is replaced by the lateral sacral artery which is branch of short common trunk of internal iliac artery.
- It arises from the dorsal face of the aorta at the angle of divergence of the internal iliacus backward on the ventral face of the sacrum and is continued as the middle coccygeal artery.

COCCYGEAL ARTERY

- It gives off in its course, spinal branches to the coccygeal muscles and two lateral coccygeal arteries.
- These divide into dorsal and ventral branches and are connected with the middle coccygeal artery at regular intervals.
- They supply branches to the coccygeal muscles.
- The middle coccygeal artery runs through the haemal arches of the coccygeal vertebrae and supplies coccygeal muscles.

HORSE

- Circle of Willis or circulus arteriosus is formed at the interpenduncular space of the base of the brain by the union of the anterior cerebral arteries in front, posterior cerebral arteries behind and is completed laterally by the junction of the later with the posterior communicating arteries and by the internal carotid artery.
- It is irregularly polygonal in outline and surrounds the optic chiasma and hypophysis cerebri.
- There is no rete mirabile cerebri in the horse.
- The intercostal arteries are 18 pairs in number.
- The coeliac artery – It divides into
    - Left gastric
    - Hepatic
    - Splenic branches
- The left gastric artery gives off pancreatic, esophageal, parietal and visceral branches.
- The hepatic artery divides into pancreatic, right gastric and gastro duodenal branches.
- The splenic artery is the largest of the three. It provided pancreatic, splenic, left gastroepiploic artery anastomoses with right gastroepiploic branch of hepatic artery after coursing along the greater curvature of the stomach.
- The middle sacral artery is absent. However, the median coccygeal artery, an unpaired vessel originates from the posterior gluteal (right or left) artery takes the position of median sacral artery of ox.
- The arteries and vascular arches of the limbs,

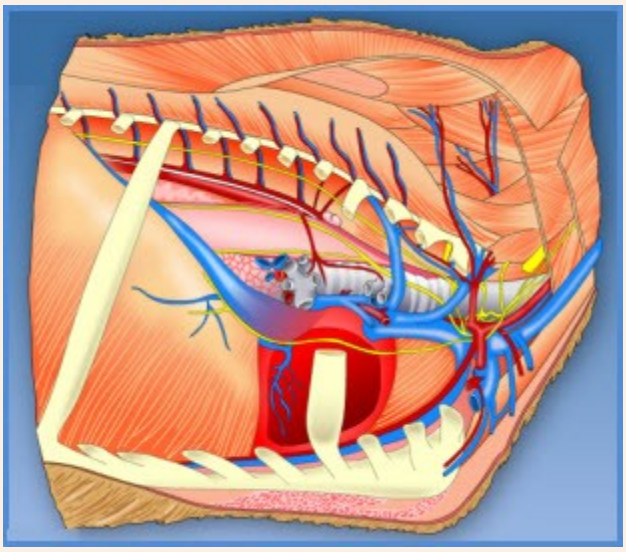
- In the horse, the place of the collateral radial and collateral ulnar arteries is taken anterior radial and ulnar arteries, which arise as collateral branches of the brachial artery. The anterior radial artery supplies the extensors of the carpus and digit.
- The ulnar artery anastomoses with the lateral volar metacarpal artery, one of the branches of the median artery under the cover of the flexor carpi ulnaris above the carpus to form supracarpal arch.
- From this arch the lateral volar metacarpal artery descends downwards and below the carpus, it anastomoses with the medial volar metacarpal artery, a branch of the median to form the subcarpal or deep volar arch between the inferior check ligament and the suspensory ligament.
- From this arch two vessels descend between the large and the small metacarpal bones on the posterior face and at the lower third they join together and this united vessel joins the large metacarpal artery or digital artery to form the distal volar arch.
- The median artery continues as the large metacarpal artery or common digital artery, which divides into medial and lateral digital arteries. In the metacarpal region, it runs along the medial border of the flexor tendons and the vein in front and nerve behind.
- Each digital artery descends parallel to the tendon of the deep flexor of the digit in company with the nerve and vein. At the fetlock, the artery is related to the vein in front and the posterior branch of the nerve behind. After detaching branches to the phalanges it enters the volar foramen of the third phalanx.
- In the hind limb, posterior tibial artery is large and takes the place of saphenous artery in the lower third of the leg.
- It divides into medial and lateral tarsal arteries.
- The medial tarsal artery forms and S-shaped curve at the lower third of leg and divides into two plantar arteries. From the second part of the curve arises the recurrent tibial artery, which ascends and anastomoses with the posterior femoral artery. This anastomoses may be regarded as the supratarsal vascular arch. The formation of the subtarsal arch (proximate plantar by branches of the plantar and perforating tarsal) is the same as in ox).
- From this arch, two superficial and deep plantar metatarsal arteries descend. The superficial metatarsal arteries are slender and appear to be the continuations of the planter arteries.
- They join the corresponding small metatarsal bones and unite near the fetlock with the great metatarsal artery to form the distal plantar arch.
- The great metatarsal artery is the direct continuation of the anterior tibial and passes obliquely on the anterior face of the large metatarsal bone and gains its posterior aspect and at the distal third divides into two digital arteries. The digital arteries resemble those in forelimb.

DOG

- The coeliac artery is very short and usually divides into a) left gastric, b) hepatic and c) splenic arteries.
- The lumbar arteries are seven pairs. Out of which first six pairs arise from aorta and the last pair from internal iliac arteries.
- The intercostal arteries are 12 pairs in number. First three pairs usually originate from thoracic vertebral artery and rest 9 pairs originate directly from aorta.
- The middle sacral artery is developed.
- The rete mirable cerebri is absent.
- In case of dog and pig, the left brachial artery arises independently from the aortic arch.
- The right brachial artery, however originates from the brachiocephalic trunk but very closely associated with the beginning of the left and right common carotid arteries.
- In the metacarpus and digital region two dorsal sets(superficial and deep) and two volar sets (superficial and deep) arteries are present.
- The dorsal common digital arteries (superficial set) are I to IV, which arise from cranial superficial antibrachaial artery.
- This vessel is a branch of superficial brachial artery, which is detached from the brachial artery just above elbow joint.
- The dorsal metacarpal arteries (deep set) are II to IV and are the branch of the radial and caudal interosseous arteries.

- The volar common digital arteries are I to IV (superficial set) and are the branches of median and caudal interosseous arteriesO.The volar metacarpal II to IV (deep set) arteriesoriginates from the radial and caudal interosseous arteries.
- The dorsal and volar vessels communicate within themselves at the distal portion of the metacarpus and finally divide into digital arteries.
- The external iliac artery in the hindlimb also two dorsal sets and two plantar sets of vessels are present.
- Dorsal common digital arteries (superficial set) are the branches of the saphenous artery and the dorsal metatarsal arteries (deep set) are the branches of the dorsal pedal artery. The dorsal pedal artery is the continuation of the anterior tibial artery.
- Plantar common digital arteries (superficial set) originate from the medial plantar branch of the caudal division of saphenous artery.
- The plantar metatarsal arteries (deep set) are branches from lateral plantar artery, which is the branch of the posterior division of the saphenous artery.
- The pattern of distribution of these vessels is mostly similar to the forelimb.

MODULE-30: VENOUS SYSTEM



LEARNING OBJECTIVES

- This topic outlines on the venous drainage pattern.
- To study the venous drainage of udder in female animals.
- It will help the clinician to examine and administer drugs in the peripheral veins.

VENOUS SYSTEM

- The veins are the centripetal vessels of the circulatory system. The veins may be divided into superficial and deep.
- The superficial veins of the body form an extensive network, lie immediately under the skin and are mostly unassociated with the arteries.
- The deep veins are placed deeply and are accompanied by the arteries.
- The anastomoses formed by the vessels of the venous system are larger, more frequent and complicated than those of the arterial system.
- Numerous such anastomoses give raise to the formation of the venous plexuses.
- Most of the veins are the satellites of the arteries and need no special description.
- Therefore, only few important venous distributions, which under go independent courses, will be discussed here.

VENOUS DRAINAGE OF CRANIUM

- The venous blood is drained from the brain by small cerebral veins, which are devoid of muscular coat and valves.
- They do not accompany the cerebral arteries.
- They lie in the piamater and subarachnoid space.
- The ascending cerebral veins drain the convex and medial faces of the hemisphere and open into the dorsal longitudinal (some into the transverse) sinus of the dura mater.
- The descending cerebral veins drain the ventral part of the convex face of the hemisphere and open in to the vena rhinalis posterior.
- The basal cerebral veins from the trunk, the rhinalis posterior joins the dorsal petrosal sinus.
- The deep cerebral veins draining the basal ganglia and choroid plexuses join to form the great cerebral vein, which passes upwards and backward behind the splenium of corpus callosum and is continued, as the straight sinus, which joins the dorsal longitudinal sinus.
- The dorsal cerebellar veins drain into the occipital and dorsal petrosal sinuses.
- The ventral cerebellar veins go to form the basilar plexus.
- The veins from pons and medulla join the basilar plexus and the occipital and dorsal petrosal sinus.

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SINUSES OF THE DURA MATER

- These venous sinuses are the spaces between the meningeal and periosteal layers of the dura mater and are lined by endothelium.
- These receive the cerebral, meningeal and diploic veins and communicate with veins outside the cranium by means of emissary veins.
    - The *dorsal longitudinal (sagittal) sinus* is situated in the convex border of the falx cerebri and receives the ascending cerebral veins.
    - The *ventral longitudinal sinus* is smaller and is situated in the concave edge of the falx cerebri.
    - The *straight sinus* is situated at the junction of the falx cerebri and tentorium cerebelli.
    - The transverse sinuses are two in number. They are situated along the convex margin of tentorium cerebelli. The two sinuses are connected by a sinus communicans.
    - The *dorsal petrosal sinuses* are the direct communication of the venae rhinalis posterior. They pass in the tentorium cerebelli and join the transverse sinuses at the internal opening of the temporal canal.
    - The *ventral petrosal sinuses* lie along the lateral borders of the basioccipital enclosed in the thick dura closing the foramen lacerum.
    - The *cavernous sinuses* are situated on the internal surface of the wings of the post sphenoid on either side of the sella turcica and are connected with each other by an intercavernous sinus behind the pituitary body.
    - The *occipital sinuses* are situated in the dura on either side of the vermis cerebelli.
- The basilar plexus is situated on the internal face of the basioccipital and is continuous with the plexus in the atlas.
- Its chief emissary is the *condyloid vein* which brings it into communication with the ventral petrosal sinus.

JUGULAR VEINS

- There are two jugular veins on each side of the neck, the external and internal jugular vein.
- These drains the venous blood from the head and neck region.

Internal jugular vein

- The internal jugular vein is the smaller of the two veins and is formed by the union of occipital, thyroid and laryngeal radicles.
- It passes down the neck in company with the carotid artery vagus and sympathetic nerves and receives in its course, muscular tracheal and oesophageal radicles and terminates by joining the external jugular vein just in front of the thoracic inlet.

External jugular vein

- The external jugular vein is the larger of the two jugular veins situated in the jugular furrow.
- It is formed by the union of the superficial temporal and internal maxillary veins on deep face of the vertical rami of the mandible and parotid salivary gland.
- It becomes superficial by emerging through the gland passes down the neck subcutaneously in the jugular furrow where it is separated from the carotid artery by the sternocephalicus and omohyoideus muscles.
- It receives along its course the external maxillary vein, parotid veins, auricular veins, muscular radicles and the cephalic vein and internal jugular vein at its termination. The external jugular veins of either side join together with the brachial veins to form the anterior vena cava.

ANTERIOR VENA CAVA

- The anterior vena cava is formed by the union of the external jugular vein and brachial vein on either side.
- This is a large venous trunk receiving venous blood from the head, neck, fore limbs and a large part of the thoracic wall.
- It is about 10 to 14 cm long and it passes in the anterior mediastinum below the trachea and right vagus, deviating to the right of the brachiocephalic trunk and its branches.
- It opens into the right atrium where it is covered by pericardium.
- It receives in its course the internal thoracic vein and the thoracic duct at the thoracic inlet on its superior face.

VENA HEMIAZYGOS

- This is a large unpaired vein situated on the left side of the roof of thoracic cavity.
- It arises from the first lumbar vein receives radicles from psoas muscles, runs forwards and downwards to the level of the 8th dorsal vertebra, partly in contact with the bodies of the vertebrae and partly in contact with the upper face of the thoracic aorta, runs on the left dorsal face, passes downwards across the left of the aortic arch under the vagus and cardiac nerves passes obliquely downwards and backwards over the left auricle and joins the cardiac vein.
- It receives veins from the vertebrae, diaphragm, and intercostal veins excepting first three on the left and the first six on the right.

CEPHALIC VEIN

- The cephalic vein is formed by the upward continuation of the medial metacarpal vein.
- It passes subcutaneously upward and forwards in an oblique manner on the medial face of the forearm then upward in the arm to about its middle and is connected with the median vein by an anastomotic branch, medial cubital vein.

- It then runs in the groove between the brachiocephalicus and anterior superficial pectoral inwards and terminates by joining the external jugular vein in front of its termination.
- The accessory cephalic vein lies on the dorsal surface of the carpus and is a tributary of the cephalic vein.
- It is formed by the dorsal metacarpal vein.

SUBCUTANEOUS THORACIC AND ABDOMINAL VEIN

Subcutaneous thoracic vein (External thoracic vein)

- This vein is inconstant.
- It arises from the region of the flank and the abdominal wall and passes forwards under the cutaneous muscle in company with the nerve of the same and joins the deep brachial vein in the axilla.
- It may join the brachial or subscapular veins.
- It is very large and is always present in the horse as the spur vein.

Subcutaneous abdominal vein

- In the male, it is small and drains the venous blood from the inguinal region.
- It passes forwards under the cutaneous muscle, passes through a foramen in the rectus abdominis and joins internal thoracic vein (for description in female see veins of udder).

POSTERIOR VENA CAVA

- It is the largest venous trunk in the body.
- It is formed under the body of the fifth lumbar vertebra by the union of the two common iliac veins(each common iliac vein is formed by the union of the external and internal iliac veins).
- It receives the middle sacral vein passes forwards below the bodies of the lumbar vertebrae slightly to the right of the median plane and the abdominal aorta.
- It leaves the company of the aorta about the level of hiatus aorticus downwards and forwards reaches the upper part of the left border of the liver runs forwards partly embedded along the left border of the liver.
- Then it passes through the foramen vena cava and enters the thoracic cavity runs forwards in the groove between the mediastinal and diaphragmatic lobes of the right lung in company with the phrenic nerve enclosed in a special fold of the pleura and opens into the posterior part of the sinus venorum of the right auricle.

- Its tributaries are,
    - Common iliac veins
    - Middle sacral vein
    - Internal spermatic veins
    - Renal
    - Hepatic and
    - Phrenic veins

SAPHENOUS AND RECURRENT TARSAL VEIN

Saphenous vein

- It is a subcutaneous vein on the medial surface of the thigh and leg.
- It is the upward continuation of the medial metatarsal vein arising from the deep plantar arch.

- It runs upwards in the distal part of the leg just anterior to tendo-achilles and is accompanied by the saphenous artery and tibial nerve.
- In the proximal part of the leg joins the femoral vein in the femoral canal.

Recurrent tarsal vein

- It is a subcutaneous vein on the lateral surface of the leg and is formed by the dorsal metatarsal vein and the lateral planter metatarsal vein.
- It communicates with anterior tibial and saphenous veins.
- It ascends and joins the deep femoral or posterior femoral vein.

PORTAL VEIN

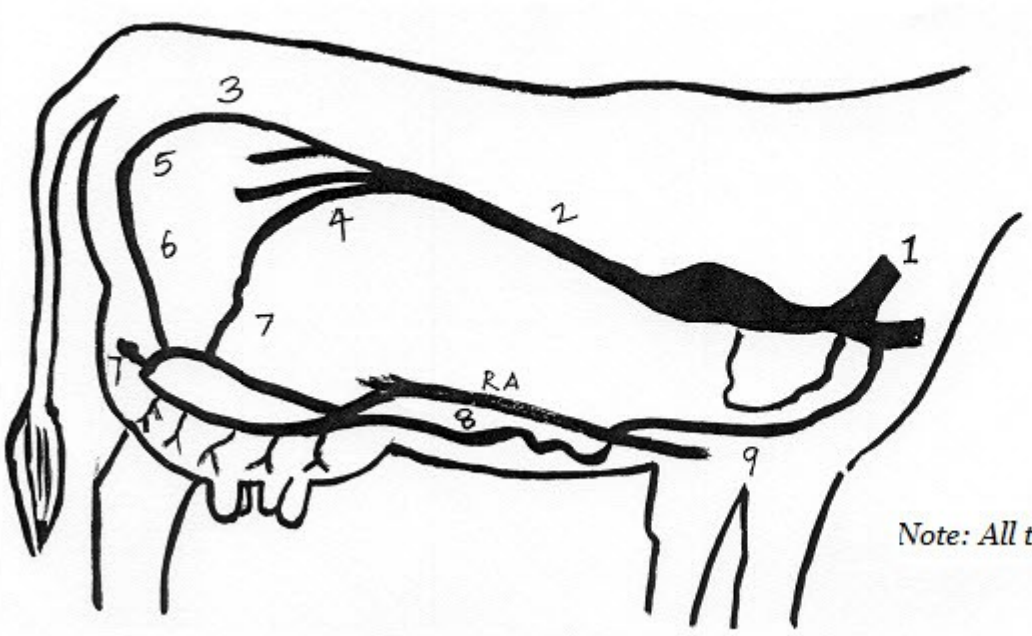
- This is a large venous trunk draining the blood from the stomach and intestine and contains the digested nutrients, which are absorbed from the small intestine and destined to reach the liver. It is formed by the union of two trunks, gastric and mesenteric.
- The gastric trunk is formed by the union of the right ruminal, splenic, left ruminal, reticular and omaso-abomasal veins.
- It also receives the gastro-duodenal and pancreatic veins. The mesenteric trunk is formed by the union of anterior and posterior mesenteric veins.
- The portal vein thus formed runs downwards and forwards to the right passes through the pancreatic notch, gains the portal fissure of the liver and divides into branches to supply the liver with functional blood.

VENOUS DRAINAGE OF UDDER

- Mammary veins deserve special notice. They form a venous circle at the base of the udder, which is drained chiefly by two pairs of vein.

- The external pudic vein in the cow is of large size and forms one of the mammary vein.
- The other veins of the mammary gland are subcutaneous abdominal and perineal veins. Of these, subcutaneous abdominal and external pudic veins are large and therefore form the principle veins of the gland. They arise from the rich venous plexus at the base of the mammary gland.
- The paired anterior mammary or milk vein (subcutaneous abdominal vein) is very large in animals of dairy breeds.
- It leaves the anterior border of the udder about 7 cm from the linea alba runs a flexuous course forwards along the floor of the abdomen, dips under the cutaneous muscle passes through the foramen in the rectus abdominis and joins the internal thoracic vein.
- The two subcutaneous veins are connected by a transverse anastomosis and each is connected behind with the middle mammary vein.
- The paired middle mammary vein (external pudic vein) is also large and ascends in the inguinal canal as a satellite of the artery and joins the external iliac vein.
- Both are connected behind by a transverse branch from which arises, a single posterior mammary vein (perineal vein), which runs medially upwards to the perineum and joins the internal pudic vein.

Schematic diagram showing the venous drainage of udder in cow

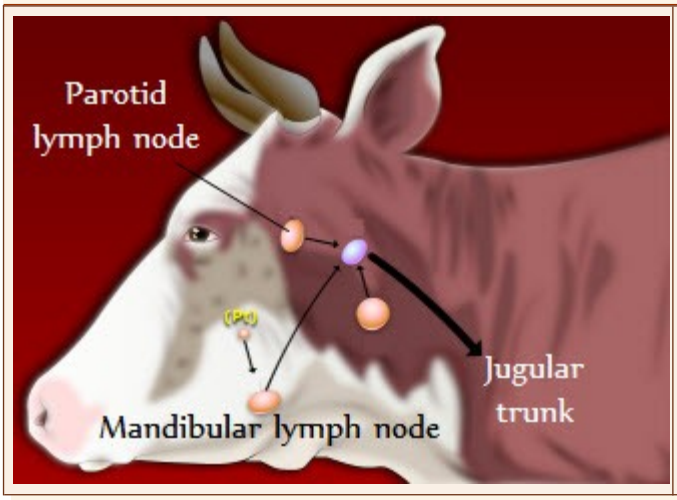


1. Anterior venacava
2. Posterior venacava
3. Internal iliac vein
4. External iliac vein
5. Internal pudic vein
6. Perineal vein
7. External pudic vein
8. Anterior mammary (r
9. Internal thoracic vein

RA - Rectus abdominu

Note: All the veins except the perineal v

MODULE-31: LYMPHATIC SYSTEM



LEARNING OBJECTIVES

- To study the pattern of lymphatic drainage, course of lymph vessels and distribution.
- To study the lymph reservoir, its formation and drainage.
- To learn about thoracic duct, tracheal lymph ducts and their drainage.

LYMPHATIC SYSTEM

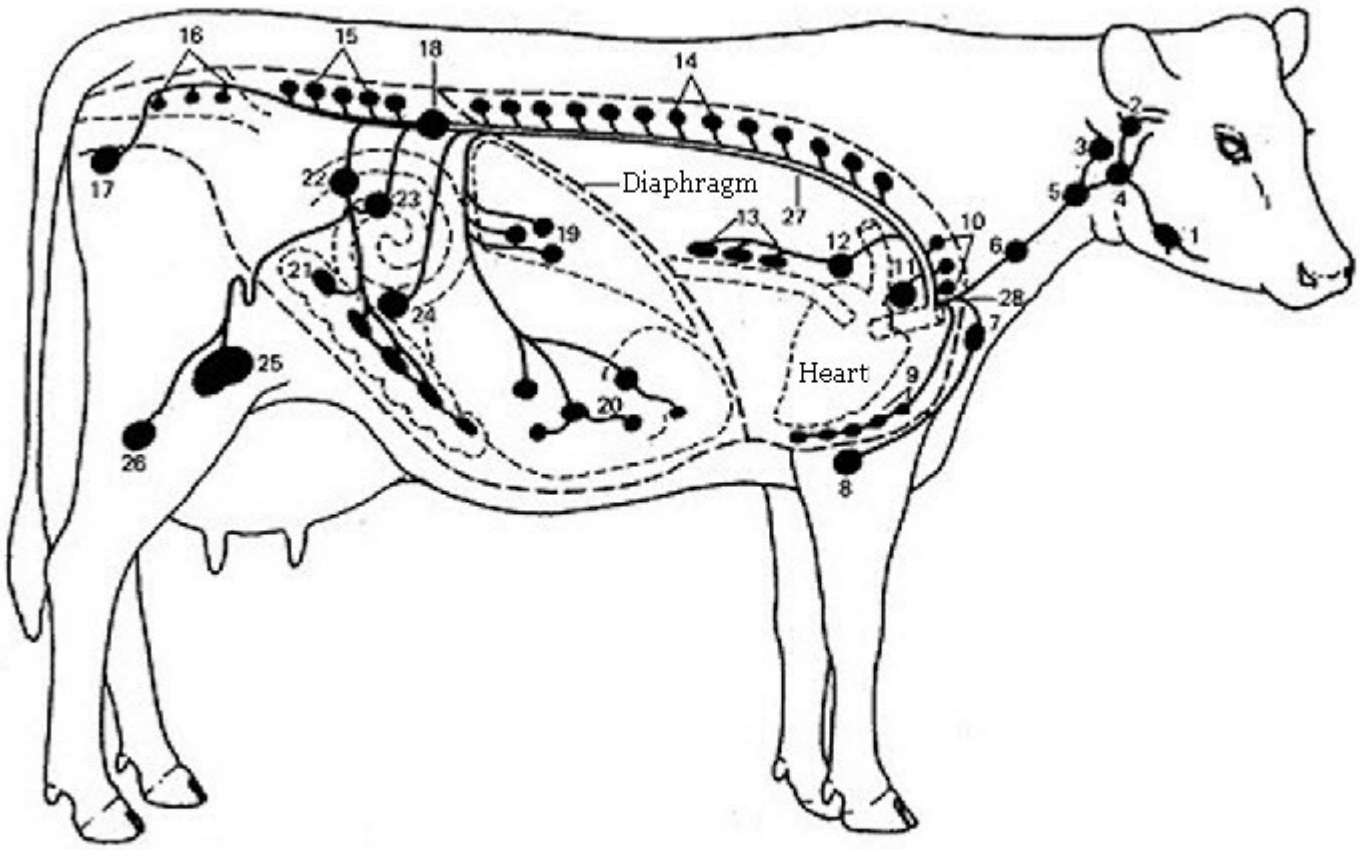
- This system consists of the lymph vessels and lymph glands connected with the venous part of the blood vascular system, containing the lymph.
- The lymph is a colorless tissue fluid drained by lymphatics.
- The vessels are other than the blood vessels, which transport tissue fluid to the blood stream.
- The walls of the vessels are very much thinner than those of the veins but are provided with numerous valves, which allow the lymph to flow at one direction. When full, they present characteristic beaded appearance.
- The flow of lymph is very slow. The vessels pass through lymph nodes.

- All the lymph vessels in the body ultimately unite together into two large trunks, the thoracic duct and right lymphatic duct which open into the venous system.
- The lymph glands or nodes are oval or bean shaped structures of variable sizes ranging from very minute bodies to the size of the lemon.
- They are intercalated in the course of the lymph vessels. The hilum is in a depressed area where the blood vessels and efferent lymph vessels enter or leave the gland. Lymph passes through at least one lymph gland before it empties into the venous system.
- Lymph vessels, which carry lymph towards the lymph gland are called as afferents and those, which carry the lymph away from the lymph gland, are known as efferents.
- The afferent vessel found at different points along the convex surface of the node Although variable in number the lymph nodes are constantly found in the certain definite areas such as inguinal region, mesentery, prescapular area and supramammary, etc.
- The haemal lymph glands are dark red in colour and these have no afferents or efferents but have the blood directly passing through their channels.
- Lymph capillaries drain into lymph vesels, lymph ducts and lymph trunks. They carry the tissue fluid to blood stream. Ultimately lymph empties into the venous angle or jugular confluence or to cranial vena cava. Wall of lymph vessel presents individual muscular segments developed between adjacent valves. Such a segment is known as **lymphangion**. It is the basic unit of lymph transportation. The vessels pass through lymph nodes. All the lymph vessels in the body ultimately unite together into two large trunks, the thoracic duct and right lymphatic duct which open into the venous system.

Lymph vessels

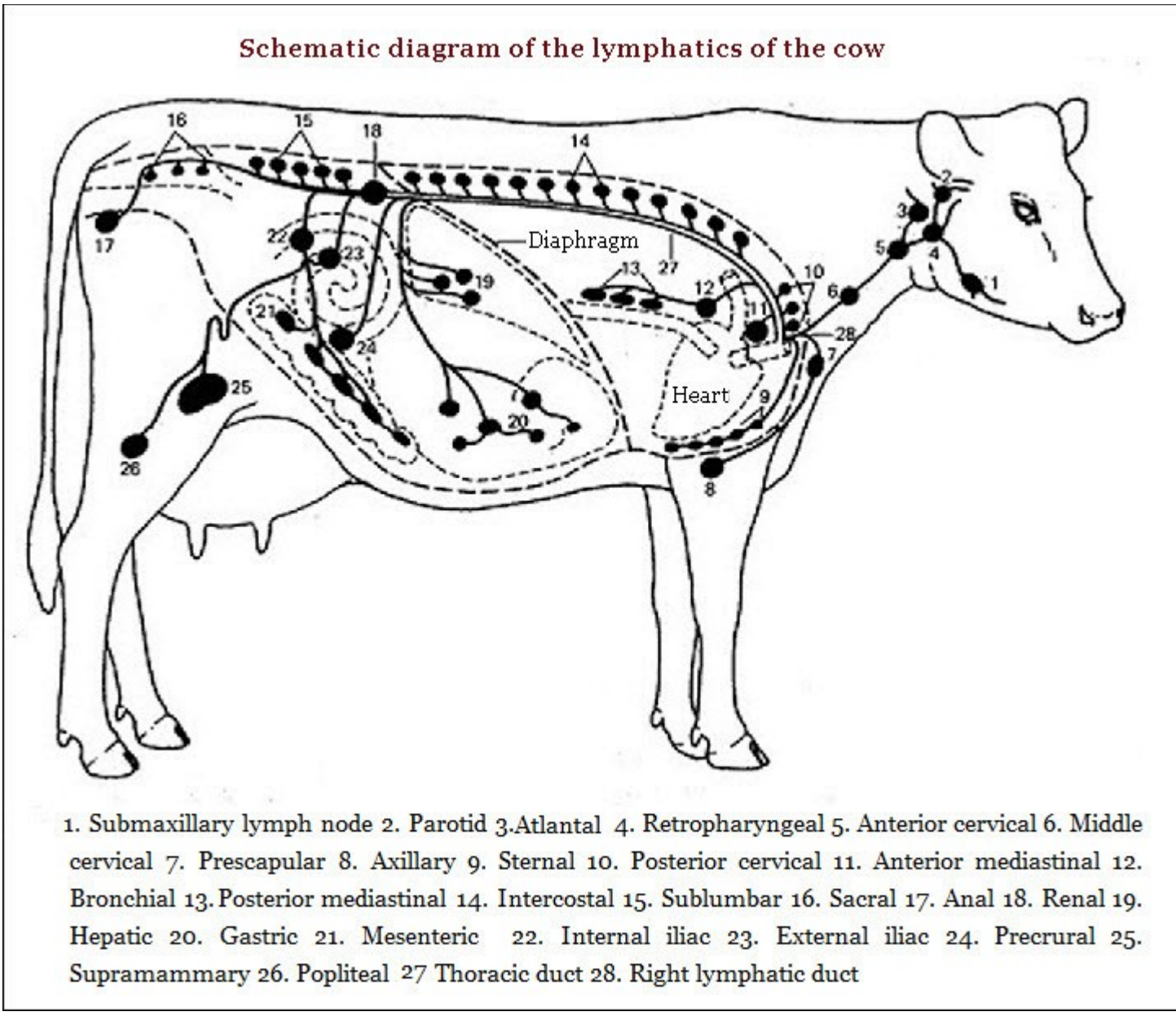
- It has already been pointed out that the lymph capillary is followed by the lymph vessel (240 A, B) which has a wider lumen. It is the function of this vessel to carry the lymph from the lymph capillary to the lymph node and finally to the blood stream. Since the first lymph .valves are situated in this region, the direction of flow is centripetal and we therefore call these vessels *"conducting vessels"*. Like the capillary netWork, these conducting vessels have numerous branches which are interconnected into a eticulation. They do not differ from the capillaries in the structure of their walls but they are of greater calibre and bear a large number of cusped valves. The forces which drive thelymph cenuipetally along these vessels are exerted from outside. In the conducting vessels of the skin such forces can result from the tension of the vessels during movement. In the conducting vessels of the locomotor apparatus the forces are due to the contraction of neighbouring muscle bundles. Co';;'ducting vessels are situated along the intestines running from the mucous membrane to the peritoneum and passing between the bundles of intestinal muscles and they are therefore expressed during peristaltic movement.
- On the other hand the more distally situated sections of lymph vessels have muscle fibres in their own walls and are themselves capable of movement. For this reason we refer to them as the *"transport vessels"*. They also have numerous, regularly-distribUted valves and these divide the transport vessel into a chain of valved segments. Each *valve segment,* also known as a *lymphangion,* therefore consists of a pair of valves and the following length of vessel, which has a lining endothelium and a *atff of muscle tissue*.Depending on the size of this vessel, the cuff consists of one or more layers of muscle fibres arranged in a complex pattern. It is interesting to note that. the walls of small transport vessels are free from muscle fibres at the point of insertion of the valves. Thus the muscular cuffs of the individual lymphangion are separated from one another and can function independendy. If lymph flows from the periphery towards a valve segment then it distends betWeen the valves, because the muscular cuff relaxes and the vessel can be stretched. When the segment is filled, muscle contraction follows with the result that the lymph in the valve segment is put under pressure. The entry valve now closes and the lymph is released centripetally through the passively opened exit valve into the next lymphangion. In this latter lymphangion the muscular cuff is again stretched and the process repeated.

Schematic diagram of the lymphatics of the cow



1. Submaxillary lymph node 2. Parotid 3.Atlantal 4. Retropharyngeal 5. Anterior cervical 6. Middle cervical 7. Prescapular 8. Axillary 9. Sternal 10. Posterior cervical 11. Anterior mediastinal 12. Bronchial 13. Posterior mediastinal 14. Intercostal 15. Sublumbar 16. Sacral 17. Anal 18. Renal 19. Hepatic 20. Gastric 21. Mesenteric 22. Internal iliac 23. External iliac 24. Precrural 25. Supramammary 26. Popliteal 27 Thoracic duct 28. Right lymphatic duct

THORACIC DUCT AND LYMPH TRUNK



Thoracic duct

- The thoracic duct is the chief collecting trunk of the lymphatic system.
- It drains lymph from all parts of the body except the right forelimb, right side of head neck and thorax.
- It extends from about the level of the first lumbar vertebra forwards a little beyond the thoracic inlet.
- Its beginning is in the form of a reservoir, the cisterna or receptaculum chyli. This reservoir is formed by the meeting of the two lymphatic trunks, The lumbar trunk and gastro intestinal trunk.
- The cisterna chyli is in the form of elongated dilatation and lies in an oblique manner upwards and forwards a little above and in front of the level of the hiatus aorticus, between the first and second lumbar arteries and on the right face of the right crus of diaphragm.
- It may also be found lying a little lower down or behind the right crus of the diaphragm when its position will be to the left of the posterior vena cava.

- The duct proceeds from the anterior aspect of the cisterna chyli is the thoracic duct, which passes forwards and slightly upwards, enters the thoracic cavity through the hiatus aorticus and crosses the right face of the terminal part of the thoracic aorta to gain its dorsal face.
- The thoracic duct from the cisterna chyli passes forwards on the right part of the dorsal face of the aorta covered by pleura and fat. The thoracic duct may remain single in some cases. But generally divide into two branches At the 6^{th} or 7^{th} dorsal vertebra it inclines ventrally crosses obliquely over the left face of the oesophagus, passes forward on the left face of the trachea to the thoracic inlet. The extra thoracic part is on the deep face of the left scalenus muscle.
- It curves backwards and inwards under the bicarotid trunk and opens on the dorsal face of the left jugular confluence or anterior vena cava. In its course it receives efferents of the intercostal, mediastinal and bronchial glands and at thoracic inlet it receives the duct from the left posterior cervical and left tracheal duct.
- The chief tributaries are gastro intestinal trunks, efferents of the mediastinal lymph glands and in its termination, the efferents of the posterior cervical, left costocervical, prescapular and sternal lymph glands and left tracheal duct.

Lumbar trunk

- The lymph conveyed by the lymphatics from the hind limb, pelvic walls and organs, inguinal structures and the abdominal walls, finally reaches either the lumbar lymph glands placed in the sublumbar region or the efferents of these glands.
- The efferents leaving these lumbar glands from two lumbar trunks, which unite to form single lumbar trunk. This in its turn joins the gastrointestinal trunk to form the cisterna chyli.
- The lumbar trunk is formed by the union of the efferents from the iliac lymph glands. It also receives efferents from the lumbar and renal glands.
- The gastro-intestinal trunk is formed at the ventral face of the posterior vena cava just behind the dorsal border of the liver by the confluence of the radicles gastric and intestinal branches. The gastric trunk is on the left of the coeliac artery.
- The intestinal trunk follows on the anterior mesenteric artery.
- The trunk formed by the union of these two trunks, bends dorsally between the aorta and posterior vena cava and unites with the lumbar trunk.

RIGHT LYMPHATIC DUCT AND TRACHEAL DUCT

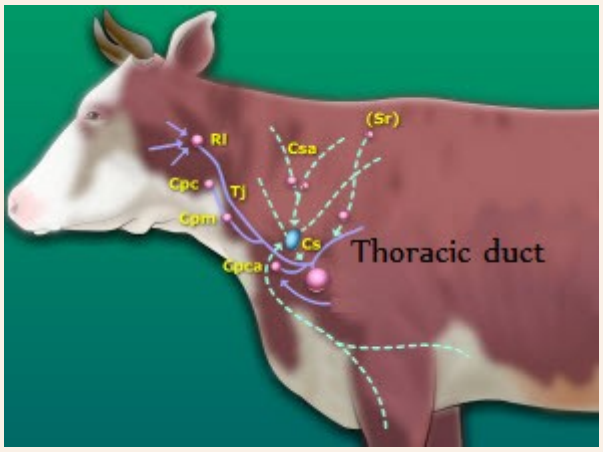
Right lymphatic duct

- It is a short (usually absent) vessel, which drains the lymph from the right side of head, neck, right forelimb and thorax. When absent, several ducts open directly into thoracic duct or jugular confluence.
- It is formed by the union of right tracheal lymph duct and the efferents of right posterior cervical and right axillary glands.
- It lies on the deep face of the scalenus above terminal part of the right jugular vein.
- It opens into the anterior vena cava.

Tracheal duct

- These are right and left and are formed essentially by the confluence of efferent vessels from the atlantal lymph gland.
- They receive efferents of cervical, costocervical and prescapular glands.
- They pass along each side of the trachea and oesophagus in relation to the carotid arteries.
- The right duct joins the efferents of the posterior cervical and costocervical glands to form the right lymphatic duct or it may join the right common jugular vein.
- The left duct opens into the thoracic duct.

MODULE-32: LYMPH NODE

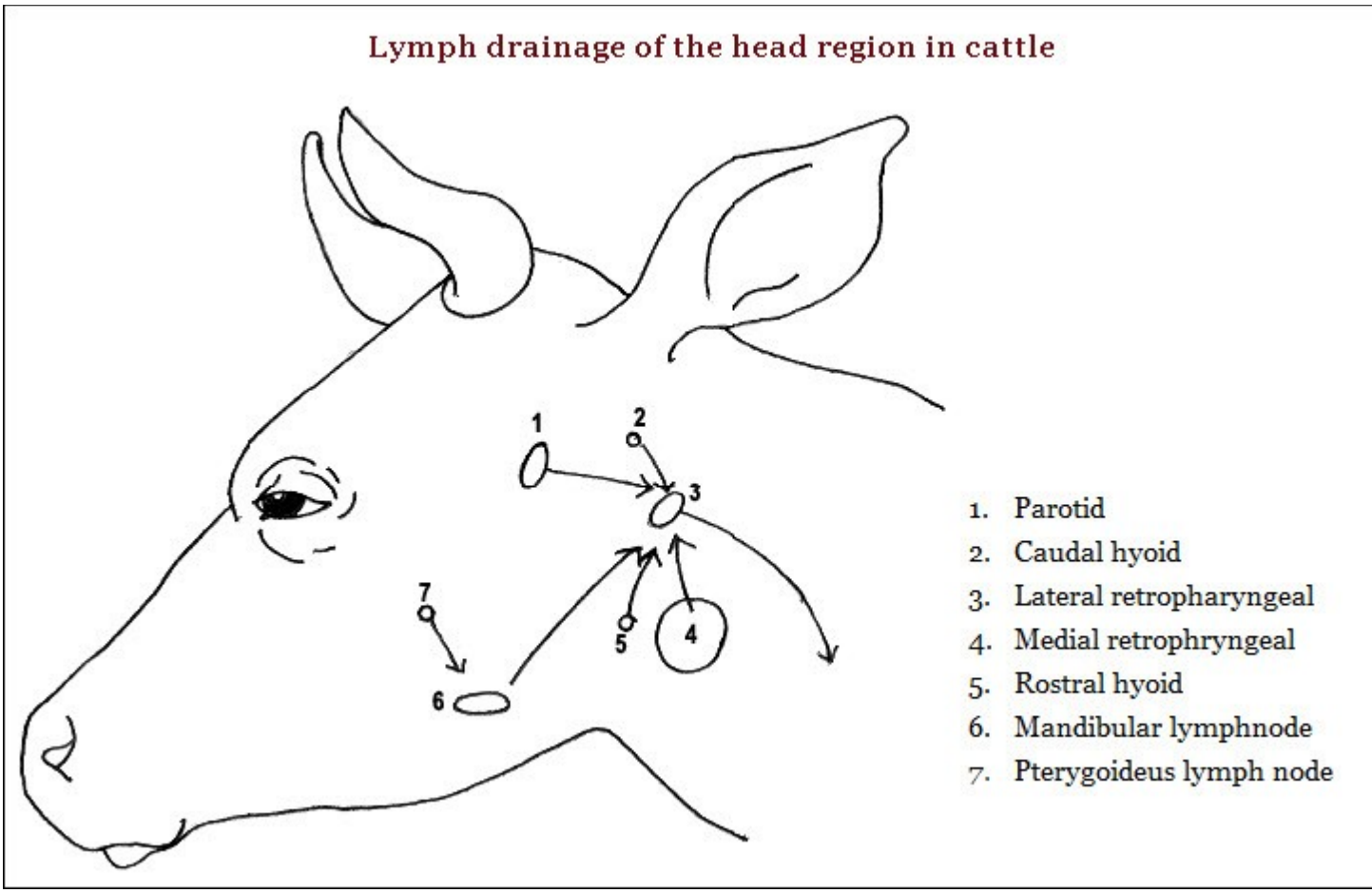


LEARNING OBJECTIVES

- To study the afferents and efferents of the lymph nodes, cysterna chyli and thoracic duct.
- It will help the clinician and meat inspector to examine the lymph nodes which are palpable for disease diagnosis and meat inspection respectively.

THE LYMPH NODES OF THE HEAD

- Pterygoid lymph node
- Parotid lymph node
- Mandibular lymph node
- Suprapharyngeal lymph node
- Peripharyngeal lymph node
- Atlantal lymph node



Pterygoid lymph node

- It is a very small gland (absent in horse and dog) situated on the upper part of the lateral face of the pterygoid near the maxillary tuberosity.
- *Afferents:* Hard palate, gums etc.
- *Efferents:* To mandibular node.

Protid lymph node

- It is situated superficially on the lateral face of the posterior portion of the masseter muscle partly under cover of the parotid salivary gland.
- *Afferents:* Muscles of the head, eye, eyelids, external ear, parotid salivary glands, lips, cheeks, anterior part of turbinates, frontal, nasal, malar and premaxillary bones.
- *Efferents:* To atlantal node.

Mandibular lymph node

- It is situated superficially on the lower part of the mandibular salivary gland below the external maxillary vein and is covered by the tendon of insertion of sterno mandibularis.
- *Afferents:* Cheek, tongue, hard plate, gums, sublingual salivary gland, muscles of head and bones of the skull.
- *Efferents:* To atlantal nodes.

Suprapharyngeal lymph node

- These are situated close together on the median line of the dorsal wall of the pharynx medial to the great cornu of hyoid bone.
- *Afferents:* Tongue, hard palate, pharynx, soft palate, sublingual, mandibular salivary glands, larynx, maxillary and palatine sinuses.
- *Efferents:* To tracheal lymph ducts.

Peripharyngeal lymph node

- It is small and is situated on the lateral aspect of the pharynx inseparably blended with the tonsil under the cover of mandibular salivary gland ventral to the carotid artery and atlantal node.
- *Afferents:* Salivary glands, hyoid muscles and efferents of parotid, mandibular and suprapharyngeal lymph nodes.
- *Efferents:* To the tracheal ducts.

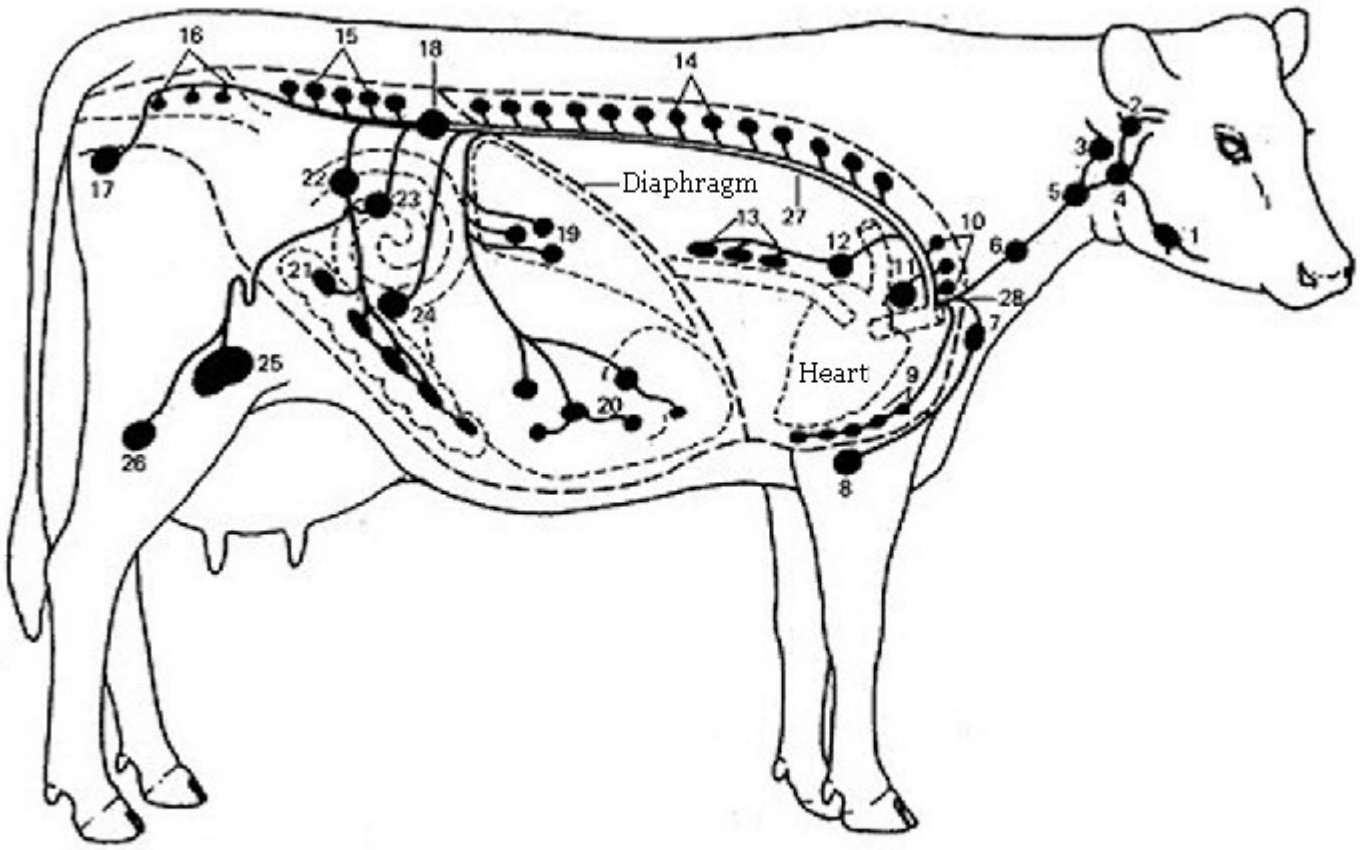
Atlantal lymph node

- It is situated below the wing of the atlas under cover of the mandibular salivary gland.
- *Afferents:* Hyoid and cervical muscles, salivary glands, tongue, efferents of parotid mandibular and suprapharyngeal nodes.
- *Efferents:* To tracheal duct.

LYMPH NODES IN THE THORACIC CAVITY

- Intercostal lymph node
- Medastinal lymph node
- Bronchial lymph node
- Pulmonary lymph node
- Pericardial lymph node
- Diaphragmatic lymph node
- Sternal lymph node

Schematic diagram of the lymphatics of the cow



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INTERCOSTAL LYMPH NODE

- These are small glands situated in the upper part of the intercostal spaces (absent in dog) on the course of intercostal vessels.
- *Afferents:* Vertebrae, ribs, pleura, intercostal and spinal muscles.
- *Efferents:* To mediastinal lymph nodes

MEDASTINAL LYMPH NODE

Anterior mediastinal lymph node

- These are situated in the anterior mediastinum along the oesophagus trachea anterior vena cava and common brachiocephalic trunk.
- Two or four are found ventral to the trachea and oesophagus. The largest often lies along the origin of the internal thoracic artery.
- *Afferents:* Pleura, trachea, oesophagus, thymus, pericardium, heart and lungs.
- *Efferents:* On the left to the thoracic duct on the right to the right lymphatic duct or costocervical nodes.

Middle mediastinal lymph node

- They are situated on the superior part of middle mediastinum over the oesophagus on the right side.
- *Afferents:* Pleura, pericardium, longus colli, vertebrae, etc.
- *Efferents:* To the efferent of the posterior mediastinal glands.

Posterior mediastinal lymph node

- These lie along the oesophagus in the posterior mediastinum
- *Afferents:* Oesophagus, lungs, pericardium, mediastinum, diaphragm, liver and spleen.
- *Efferents:* To thoracic duct.

Dorsal mediastinal lymph node

- They are situated on either side of the aorta and between it and vertebrae.
- *Afferents:* Similar to intercostal and also from diaphragm pericardium mediastinum.
- *Efferents:* To the efferent from posterior mediastinal or to the thoracic duct.

Ventral mediastinal lymph node

- These lie on the transversus thoracic muscle at the apex of the pericardium.
- *Afferents:* Pleura diaphragm pericardium and sternum.
- *Efferents:* To the anterior sternal node.

BRONCHIAL AND PULMONARY LYMPH NODE

Bronchial lymph node

- They are right, left, middle and apical bronchial nodes.
- The right bronchial is situated on the right face of the trachea.
- The left bronchial is situated between the aortic arch and pulmonary artery.
- The middle bronchial at the bifurcation of the trachea.
- The apical bronchial is at the origin of the apical bronchus.
- *Afferents:* Lungs, oesophagus bronchi and heart.
- *Efferents:* On the left to the efferents of the posterior mediastinal gland on the right to the middle mediastinal and anterior mediastinal nodes.

Pulmonary lymph node

- They are inconstant and found in the chief bronchi in the lungs.
- *Afferents:* Lungs.
- *Efferents:* To bronchial and mediastinal nodes.

PERICARDIAL LYMPH NODE

- They are small and inconstant and are found between the aortic arch and vena hemiazygos.
- *Afferents:* Pericardium.
- *Efferents:* To left bronchial node.

DIAPHRAGMATIC AND STERNAL LYMPH NODE

Diaphragmatic lymph node

- It is a small gland close to the foramen vena cava of diaphragm.
- *Afferents:* Diaphragm.
- *Efferents:* To posterior mediastinal nodes.

Sternal lymph node

- These nodes are situated along the course of internal thoracic vessels. The largest of these is the anterior sternal nodes.
- *Afferents:* Intercostal muscles, pericardium, pectoral and abdominal muscles.
- *Efferents:* To the anterior mediastinal nodes.

LYMPH NODES OF THE NECK AND FORE LIMB

Cervical lymph node

- These are placed along the course of the common carotid artery in the upper, middle and lower third of the neck as anterior, middle and posterior cervical.
- *Afferents:*
    - The larynx, trachea, oesophagus, thyroid, thymus and muscles and bones of the neck.
    - The posterior cervicals receive in addition the efferents from the prescapular and axillary nodes.
- *Efferents:* Anterior and middle cervicals go to the tracheal ducts and those from the posterior cervical on the left join the left tracheal duct or thoracic duct and on the right lymphatic duct.

Costocervical lymph node

- It is situated in front of the first rib under the scalenus muscle (absent in the horse) dorsal to the carotid artery.
- *Afferents:* Trachea, oesophagus cervical, shoulder muscles and those of intercostal and anterior mediastinal nodes.
- *Efferents:* On the left to the thoracic duct and on the right to the right lymphatic duct.

Prescapular lymph node

- It is situated at the anterior border of the supraspinatus about 10 to 13 cm, above the shoulder joint under cover of the omotransversarius and brachiocephalicus.
- *Afferents:* Skin and muscles of neck forelimb and thorax.
- *Efferents:* Similar to the preceding.

Axillary lymph node

- It is placed on the medial face of teres major.
- *Afferents:* Muscles of shoulder, arm, forearm, latissimus dorsi, shoulder, elbow and carpal joints etc.
- *Efferents:* To posterior cervical lymph nodes.

HORSE

- In addition to above, there are cubital lymph nodes situated on the branchial vessels on the medial aspect of the elbow.

LYMPH NODES OF ABDOMEN, PELVIS AND HIND LIMB

- These lymph nodes are parietal and visceral in the abdomen and pelvis.
- The former lodges in the abdominal walls while the latter are situated on the viscera contained in these cavities.
    - Visceral lymph nodes
        - Gastric lymph nodes
        - Mesenteric lymph nodes
    - Parietal lymph nodes
        - Precrural lymph nodes
        - Sacral lymph node
        - Ischiatic lymph node
        - Superficial inguinal lymph node (in the male)
        - Supramammary lymph node (in the female)
        - Popliteal lymph node

GASTRIC LYMPH NODES

- These are (i) ruminal (ii) reticular (iii) omasal and (iv) abomasal nodes.
- Three or four glands situated on the right face of the atrium are the atrial nodes.
- They receive afferents from spleen, reticulum, rumen and the efferents of the other gastric nodes.
- Their efferents unite to form a common efferent, which in turn unites with efferents of the mesenteric nodes to form the mesenteric trunk.
- One or two nodes situated in the left longitudinal groove of the rumen are the left ruminal nodes.The efferents go to anterior ruminal nodes.
- A number of nodes in the right longitudinal groove of the rumen are the right ruminal nodes. The efferents go to the gastric trunk and anterior ruminal nodes.
- A number of nodes situated in the anterior transverse groove are the anterior ruminal nodes. The efferents go to the atrial nodes.
- The nodes situated on the reticulo-omasal junction are the reticular glands. Their efferents go to atrial nodes.
- Nodes situated along the greater curvature of the omasum are omasal nodes. Their efferent goes to atrial nodes.
- Nodes situated along the lesser curvature of omasum and greater curvature of abomasum is abomasal nodes. Their efferents pass to the hepatic nodes.
- Nodes situated at the portal fissure of the liver are hepatic nodes. Their efferents go to the gastric trunk.
- The pancreatic nodes lie on the inferior face of the pancreas. The efferent joins the intestinal trunk.

MESENTERIC LYMPH NODES

- The duodenal lymph nodes are in the mesoduodenum and the efferents go to hepatic or abomasal lymph nodes.

- *Afferents:* Efferents of popliteal, superficial inguinal, precrural, abdominal muscles, urinary organs and the vesiculae seminalis.
- *Efferents:* To internal iliac nodes and lumbar trunk.

PARIETAL LYMPH NODES

Precrural lymph nodes

- It is situated superficially in front of the tensor fasciae latae about a handbreadth above the patella.
- *Afferents:* Skin of leg, thigh, hip, abdomen and muscles of these regions.
- *Efferents:* To deep inguinal and internal iliac nodes.

Sacral lymph node

- It consists of medial and lateral groups.
- The medial lymph nodes are inconstant and lie on the deep face of the sacrosciatic ligament.
- *Afferents:* Pelvic urethra, prostate and vagina.
- *Efferents:* To internal iliac nodes.
- The lateral groups consist of small nodes on the upper part to the lateral face of the sacrosciatic ligament.
- *Afferents:* Gluteus profundus, hip joint and pelvic bones.
- *Efferents:* The internal iliac and inguinal lymph nodes.

Ischiatic lymph node

- It is a small node on the lateral face of the sacrosciatic ligament at the lesser sciatic foramen under cover of biceps femoris.
- A second one often occurs at the medial side of tuber ischii.
- *Afferents:* Gluteal muscles, hip joint, rectum, anus, vulva, root of penis, prostate and bulbourethral glands.
- *Efferents:* To internal iliac nodes.

Superficial inguinal lymph node (in the male)

- It is situated above the neck of the scrotum.
- *Afferents:* Scrotum, prepuce and skin.
- *Efferents:* To deep inguinal lymph node.

Supramammary lymph node (in the female)

- It is situated above the posterior border of the mammary gland.
- *Afferents:* Mammary gland
- *Efferents:* To deep inguinal node.

Popliteal lymph node

- It is small node situated between the two heads of the gastrocnemius muscle and covered by the biceps femoris and semitendinosus muscles about the level of the stifle joint.
- *Afferents:* Muscles of hind limp and skin
- *Efferents:* To deep inguinal node.

SPECIES DIFFERENCE

Horse

- The lymph nodes are more numerous, smaller and occur in groups unlike in the ox in which they are less numerous, compact and larger.
- The mesenteric lymph nodes are situated in the great mesentery chiefly near its root.
- The cubital lymph nodes are present behind the biceps brachii on the brachial vessels and median nerve.
- Their efferents pass to axillary and prescapular glands.
- Deep inguinal lymph nodes are situated in the proximal part of the femoral canal between the pectineus and sartorius.

Dog

- The suprapharyngeal and internal iliac lymph nodes are comparatively very large.
- Posterior mediastinal lymph nodes are absent.
- Intercostal lymph nodes are absent.
- Portal lymph nodes occur in the course of portal vein.
- Mesenteric lymph nodes are two elongated nodes occurring at the root of mesentery.
- Supramammary lymph node is single or sometimes two in number related in the inguinal mammary glands.
- Popliteal lymph node is on the gastrocnemius between biceps femoris and semitendinosus.
- It is more superficial than in other animals and hence is commonly palpable.

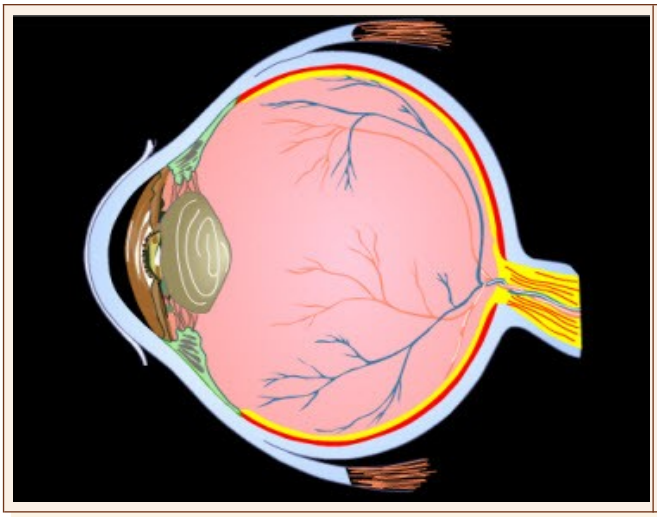
Fowl

- The lymphatics of the chicken consist of lymph vessels and lymph glands.
- The lymph nodes are very small and are in the form of lymph nodules, which are very numerous in the walls of the alimentary tract and a few are found in the cervical region.
- The lymph vessels from the abdomen and posterior part of the body join together to form a plexus about the level of the coeliac artery.
- From this lymphatic plexus a right and left thoracic duct leads forward to the jugular vein of its respective side. Before entering the jugular vein they receive the duct from the head, neck, thoracic limbs and anterior part of the body.

INTRODUCTION

- Aesthesiology deals with the description of the sense organs which receive external stimuli and conduct impulses to the brain which result in sensations of sight, hearing, taste, smell, touch, pain, temperature and pressure.
- These sensations are received and transmitted as nerve impulses to the central nervous system by receptors, which may be specialized structural modifications of the dendrites or peripheral processes of usually bipolar neurons (eye, olfactory mucous membrane, skin etc.) or may be specialized “neuroepithelial cells” which are modified epithelial cells, around the bases of which are terminations of peripheral processes of nerve cells located in sensory ganglia (internal ear, taste buds).

MODULE-33: AESTHESIOLOGY



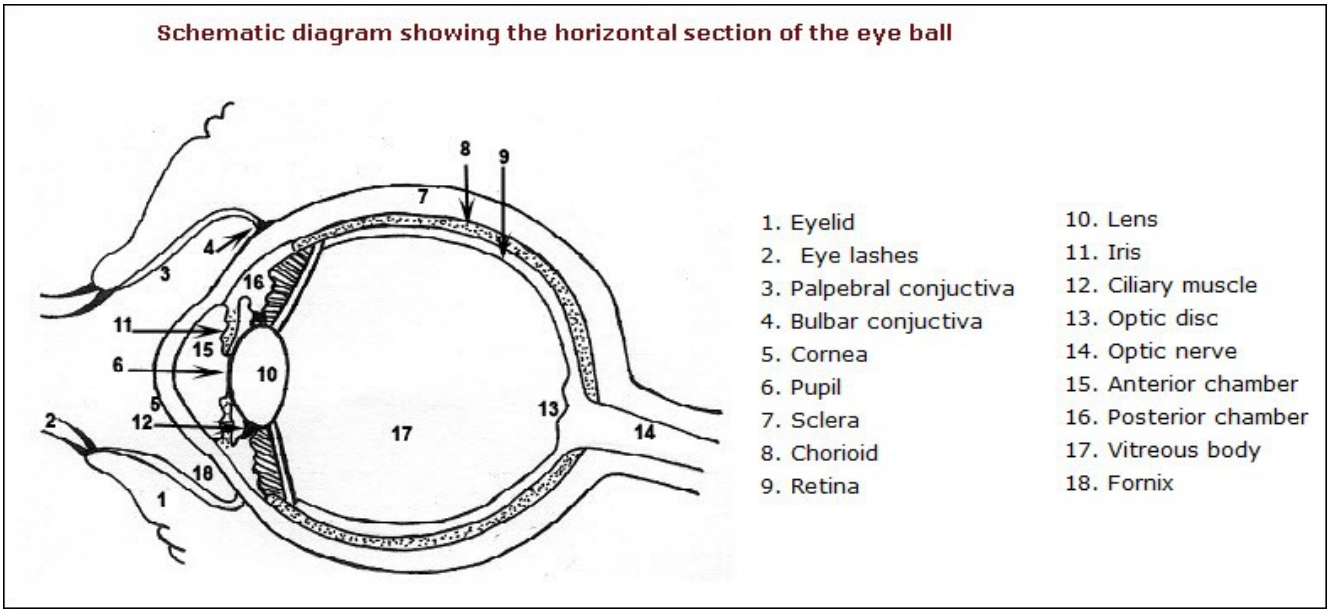
LEARNING OBJECTIVES

- To study the organ of vision and to have a better understanding on its parts like peri orbita, cornea, ciliary body, iris and retina.
- To know about the refractive media of eye.

ORGAN OF VISION

Eye

- The eye is the organ of vision.
- It comprises of the eyeball, optic nerve and certain associated structures as *orbit, orbital fasciae, muscles, eyelids, conjunctiva* and *lacrimal apparatus*.



Eyelids (palpebrae)

- The eyelids or palpebrae are two movable folds of skin situated in front of the eyeball and when closed, they cover the entrance into the orbit.
- The upper eyelid is more extensive and movable then the lower eyelid. The interval between the upper and lower eyelids is the palpebral fissure.
- It is an oblique slit and the ends are the medial and lateral canthus.

- The lateral angle is rounded but the medial one is narrow and drawn into V-shaped recess, the lacrimal recess or lake.
- In this lake, there is a round pigmented body called the caruncula lacrimalis.
- The external surface of the eyelid is convex and is covered with short hairs.
- The mucosal surface is concave, lined by the palpebral conjunctiva and is adapted to the anterior face of the eyeball.
- The free border is smooth, black and has a well defined posterior margin where the ducts of tarsal glands open and the anterior margin bears short stiff hairs-the cilia or eye lashes. These are more in the upper than in the lower lid.
- The edge of each lid is pierced near its medial angle by a small opening on either side of the caruncle - called puncta lacrimalis that are the entrances into the lacrimal ducts.
- The skin is freely movable except at the free edge.
- It consists of subcutis with no fat, palpebral muscles, palpebral ligament, fibrous layer constituting the tarsus and palpebral conjunctiva.
- The tarsal or Meibomian glands are arranged in parallel rows between tarus and conjunctiva and secrete the palpebral sebum.
- Each gland has an independent duct and opening.

Conjunctiva

- It is the mucous membrane, which lines the internal or posterior surface of the eyelids - palpebral conjunctiva.
- It is light pink in colour and is reflected on the anterior part of the eyeball as bulbar conjunctiva, the line of reflection being the fornix.
- The dorsolateral part of the fornix is pierced by the excretory ducts of the lacrimal gland about 12 to 16 in number.
- When the lids are in opposition, the capillary space between the two parts of the conjunctiva constitutes the conjunctival sac.
- Palpebral conjunctiva is continuous with the skin of the eyelid at the ciliary margin.
- The third eyelid is at the medial angle.
- It consists of a semilunar fold of conjunctiva - the membrana nictitatans that covers and encloses a curved plate of hyaline cartilage.
- The cartilage is leaf or shovel shaped in outline.
- That part which lies in the membrane is thin and wide. The deep part is narrower and thicker and is embedded in fat at the medial side of the eyeball.
- The deep part of the cartilage is surrounded by the superficial gland of the third eyelid. It resembles lacrimal gland in structure.
- Beneath the third eyelid is a mixed gland called the gland of the third eyelid or Harderian gland.
- *Blood Supply :* Ophthalmic and facial arteries.
- *Nerve Supply:* Ophthalmic and maxillary divisions of the fifth cranial nerve (sensory nerve) and facial nerve.

Lacrimal apparatus

- Lacrimal apparatus consists of lacrimal gland, excretory ducts of the gland, two lacrimal ducts or canaliculi, lacrimal sac and nasolacrimal duct.
- The lacrimal gland is situated on the dorsolateral surface of the eyeball under the supraorbital process.
- It is flattened oval and its superficial face is convex and distinctly lobulated. It resembles the parotid gland in structure.
- Its deep face is concave and is separated from the eyeball by the periorbita.
- The excretory ducts are 6 to 8 large ones and several small ones and these open into the dorso-lateral part of the fornix conjunctivae.
- The puncta lacrimalia are the entrances into the lacrimal ducts that begin here and converge at the medial angle to form a sac, the lacrimal sac that is placed in the lacrimal fossa of the lacrimal bone.

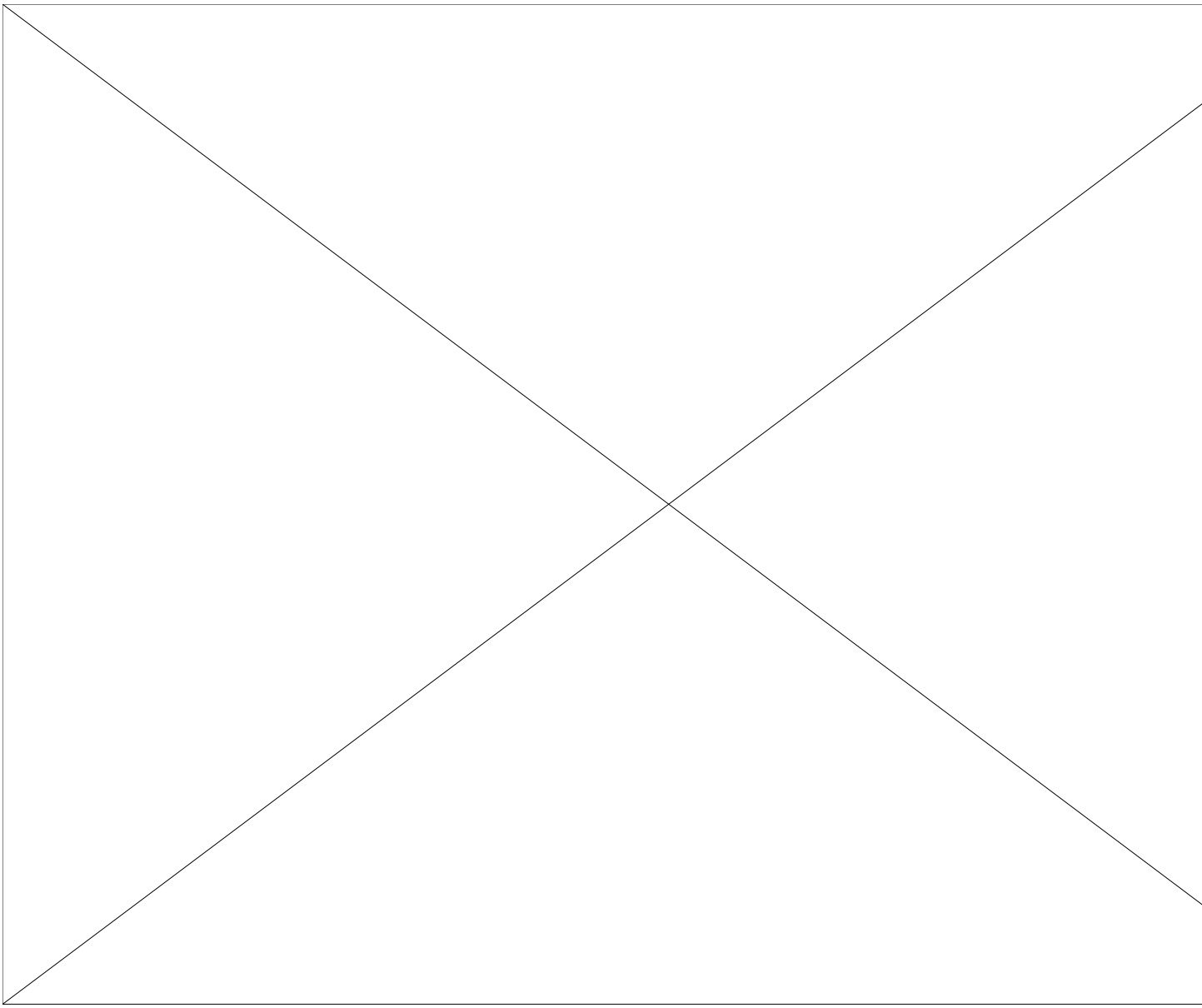
- It leads into the nasolacrimal duct that opens into the nasal cavity. The orifice is on internal aspect of the fold of the ventral turbinate and hence not visible externally as in the horse.
- *Blood Supply* : Lacrimal artery
- *Nerve Supply*: Lacrimal nerve (sensory) and secretary fibres from autonomic nervous system. View animation of lacrimal reflex

PERI ORBITA

- It is a conical fibrous sheath that encloses the eyeball with muscles, vessels and nerves.
- Its apex is attached around the optic and orbital foramina and its base is in part attached to the bony rim of the orbit, in part continues with the fibrous layer of the lids.
- Its medial part is in contact with the orbital wall, is thin; incorporated with it beneath the root of the supraorbital process is the bar of cartilage around which the superior oblique muscle is reflected.
- The lateral part is thicker and is strengthened by an elastic band that is attached to the pterygoid crest and furnishes origin to the thin, unstriped orbital muscle.
- A quantity of fat that lies about the periorbita and within it is the intra-orbital adipose tissue, which fills the interstices between the eyeball, muscles, etc.
- The orbital muscles have been studied under myology. The orbit has been studied in osteology.

TUNICS OF EYE BALL

- The tunics are three in number-*external fibrous, middle vascular* and *internal nervous*.



Fibrous tunic

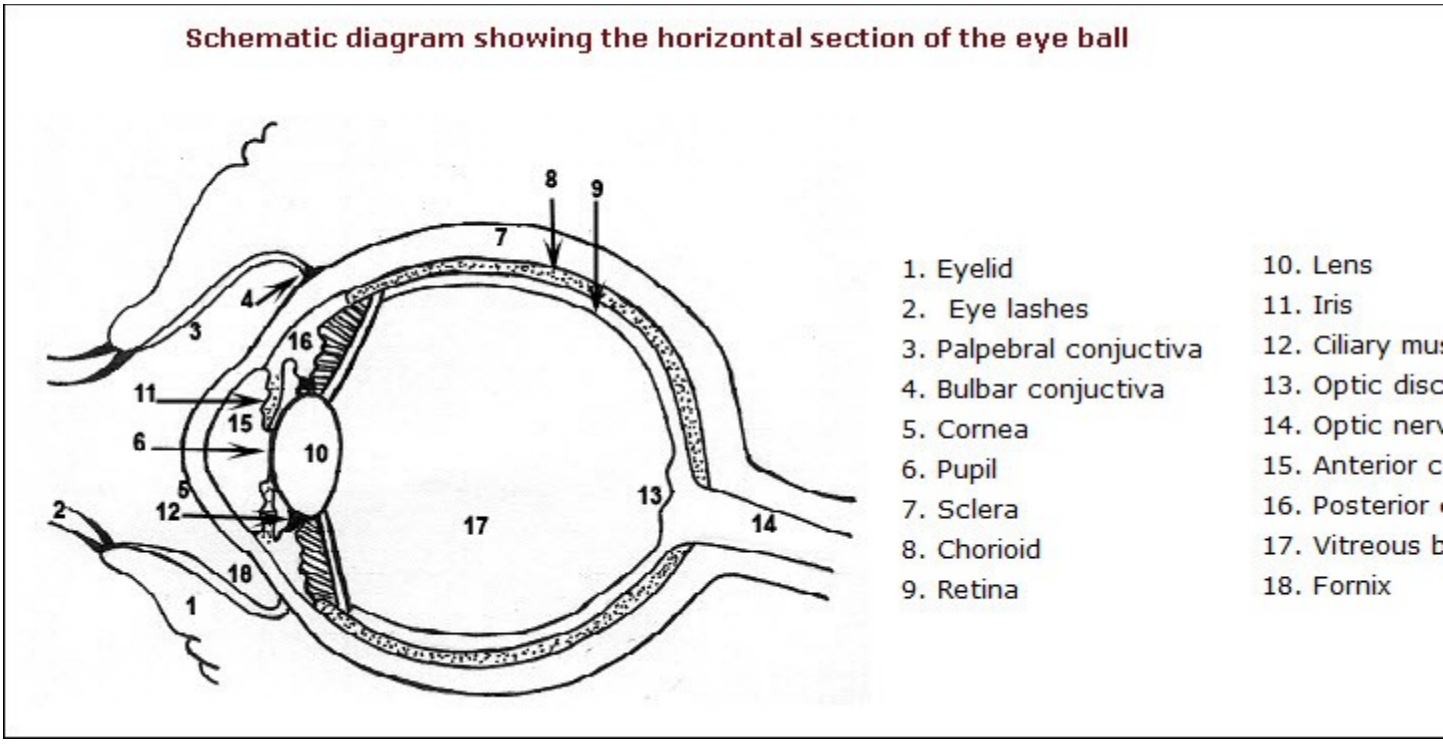
- The fibrous tunic is composed of an anterior transparent, avascular part called the *cornea* and a posterior opaque, vascular part known as the *sclera*.

CORNEA

- The cornea forms the anterior one fifth of the fibrous tunic.
- It is transparent, colorless, and avascular. It is oval, the broad end being medial.
- The *anterior surface* is convex and more curved than the sclera. The *posterior surface* is concave and forms the anterior boundary of the anterior chamber.
- The margin joins the sclera where the sclera overlaps the cornea.

Structure

- *Corneal epithelium* lined stratified squamous epithelium.
- *Lamina limitans anterior* or *Bowman's membrane* which is very thin and homogeneous.
- *Substantia propria* -lamellae of connective tissue with connective tissue corpuscles-the **corneal corpuscles** that are transparent.
- *Lamina elastica* or *Descemet's membrane*- a thick, elastic homogeneous membrane. This lamina divides at the periphery into three divisions, the *anterior part* joins the sclera; the *middle* one gives attachment to the ciliary muscle and *posterior* division passes to the iris forming the *ligamentum pectinatum iridis*.
- *Endothelium* of squamous cells; this after lining the cornea is reflected over the iris.



Note

- All the layers forming the cornea are transparent.

Blood Supply

- Cornea is devoid of blood vessels. It derives nutrition from the superficial plexus of vessels.

Nerve Supply

- Ciliary nerves.

SCLERA

- The sclera is a dense white fibrous membrane forming about four fifths of the fibrous tunic of the eyeball.

- Thickest in the vicinity of the posterior pole, it thins at the equator and increases in thickness toward the junction with the cornea.
- It is often pigmented. When non-pigmented it shows a bluish tinge.
- Its *external surface* gives insertion to ocular muscles and is covered in front by the bulbar conjunctiva.
- The *internal surface* is attached to the chorioid coat by pigmented connective tissue -the lamina fusca.
- The *anterior border* is oval, the long axis being transverse and is continuous with the cornea.
- The sclera here appears to form a bevel in which the cornea is fixed. Near the corneoscleral junction, there is a *circular venous plexus*, the plexus venosus sclerae (sinus venosus sclerae or canal of Schlemm).
- The canal will be described later under the iris angle.
- The optic nerve pierces the posterior part of the sclera a little below and lateral to the posterior pole (in the postero-ventrolateral quadrant).
- It composed of interlacing bundles of white fibres and few elastic fibres.

Blood supply

- Ciliary arteries.

Nerve supply

- Ciliary nerves.

Vascular tunic

- It lies internal to the fibrous tunic and comprises the *chorioid, ciliary body* and *iris*.

CHORIOID

- It is a thin membrane lying between the sclera and retina.
- It is loosely attached to the sclera by the lamina fusca except where vessels and nerves pass through.
- The internal surface is in intimate contact with the pigmentary layer of the retina.
- The chorioid is generally dark brown in colour but an extensive area above the level of the optic papilla has a metallic lustre, the colour varying from iridescent blue to green called the *tapetum of the chorioid*. Posteriorly it is perforated by the optic nerve.
- It is continuous anteriorly with the ciliary body.
- The tissue of the chorioid is principally made up of blood vessels with numerous pigment cells.
- It consists of the following layers,
    - (*Lamina suprachoroidea* of fibrous tissue with elastic fibres containing pigment cells
    - *Lamina vasculosa* of large blood vessels
    - *Lamina choriocapillaris* between this and the previous layer is a network of fibroelastic tissue, the **tapetum fibrosum** which gives the metallic lustre and it is here only the chorioid coat is devoid of pigment cells and blood vessels. Tapetum fibrosum is built up of bundles of laminated areolar connective tissue cells superimposed upon the chorioid to form a tendinous type of surface that reflects back the light passing through retina. This causes tapetum to glisten and exhibit various types of coloration according to species and age of the animal; (the tapetum is absent in man, monkey and pig)
    - *Lamina basalis* is thin and transparent and is made up of an inner homogeneous and an outer elastic layer.

CILIARY BODY

- It is the middle part of the vascular tunic and connects the chorioid with the periphery of the iris.

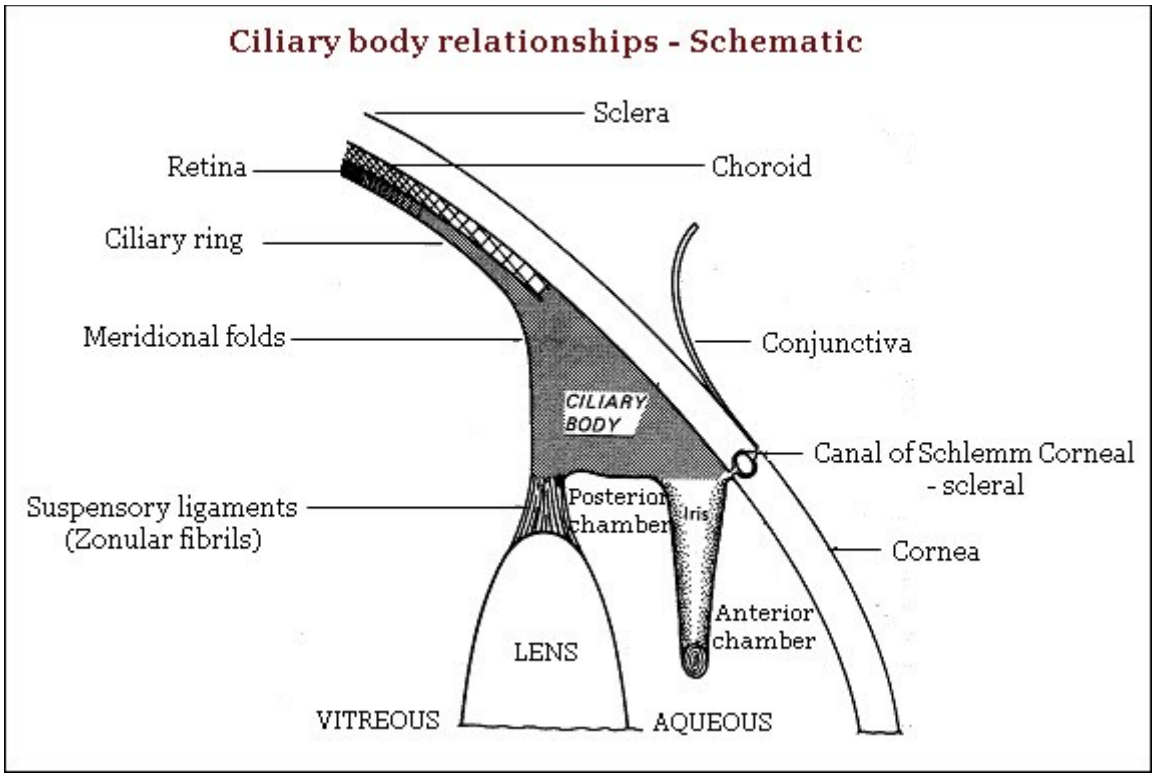
- In meridional section, it is triangular in outline with the base next to the iris. It consists of three parts, *ciliary ring, ciliary processes* and *ciliary muscle*.
- The ciliary ring is continuous with the anterior part of the chorioid and presents on its inner surface, numerous fine ridges arranged in a radial manner.
- The ciliary processes are formed by the plating and folding of the lamina propria and the lamina basalis of the chorioid and are received between the corresponding folds of the suspensory ligament of the lens The internal face of the folds is continuous with the lamina basalis there are two layers of epithelial cells that constitute *pars ciliaris retinae*.
- The ciliary muscles constitute the outer part of the ciliary body and lies between the sclera and ciliary processes.
- It forms a circular band of unstriped muscle. They arise from the inner face of the sclera and ligamentum pectinatum iridis close to the sclero-corneal junction and are inserted to the ciliary processes and ring.
- When the muscles contract, it pulls the ciliary processes forwards, thus slackening the suspensory ligament of the lens and allows the later to become more convex. This is the mechanism of accommodation for near objects.

IRIS

- It is a muscular diaphragm placed in front of the lens and is visible through the cornea.
- It is pierced centrally by an elliptical opening, the pupil.
- The ciliary border is continuous with the ciliary body and is connected with the ligamentum pectinatum iridis.
- The pupillary border surrounds the pupil. The upper margin bears small masses of pigmentary tissue called corpora nigra or granula iridis.
- The anterior surface is dark brown in colour and is lined by the reflection of the corneal endothelium. It forms the posterior boundary of the anterior chamber.
- The posterior surface is dark. Its central part is in contact with the lens but peripherally it is separated from it by an annular space called the posterior chamber.
- It is lined by endothelium. The anterior and posterior chambers communicate through the pupil and contain aqueous humor.

Structure

- This iris chiefly composed of a framework of connective tissue called the stroma iridis containing numerous pigment cells.
- The muscular tissue is unstriped and consists of a sphincter pupillae around the pupil and a dilator pupillae with fibres radiating from the sphincter to the ciliary border.
- The anterior surface of the iris is covered by a continuation of the endothelium of the cornea. Beneath this is a condensation of stroma in which the cells are close together and are filled with pigmented granules.
- The colour of the eye is determined by the pigmentation of the iridic stroma. If it contains little pigment, the pigmented epithelium on the posterior surface shows through and gives a blue coloration.
- In the cat, there is diffuse yellow pigmentation of the stromal cells and so the eye has a golden sheen. In albinos, the pigment is absent here, as elsewhere, and the iris is pink is colour.



Iris angle

- It is the angle of the anterior chamber and is so called because in meridional section, it has an angular shape.
- It is occupied by a loose spongy tissue, the meshwork of iris angle, whose outer border forms the inner wall of canal of Schlemm.
- The spaces of the meshwork are called spaces of Fontana and are in communication with the anterior chamber.
- The canal of Schlemm appears in meriodional sections as one or more endothelial lined oval spaces.
- It communicates with the anterior ciliary veins in the neighboring scleral tissue.
- Together with the spaces of Fontana, the canal forms a means of exit for the intraocular fluid. The aqueous humor secreted by the epithelium over the ciliary processes, passes from the posterior chamber, through the pupil into the anterior chamber, on reaching the angle of iris, passes through the spaces of Fontana to the canal of Schlemm.

Blood supply

- Ciliary arteries.

Nerve supply

- Long and short ciliary nerves. Parasympathetic fibres from oculomotor nerve to sphincter pupillae whereas sympathetic fibres innervate dilator pupillae.

NERVOUS TUNIC

- The *retina* forms the innermost tunic of the eyeball and extends from the entrance of the optic nerve to the iris. It consists of three parts; a posterior part the essential region containing the special

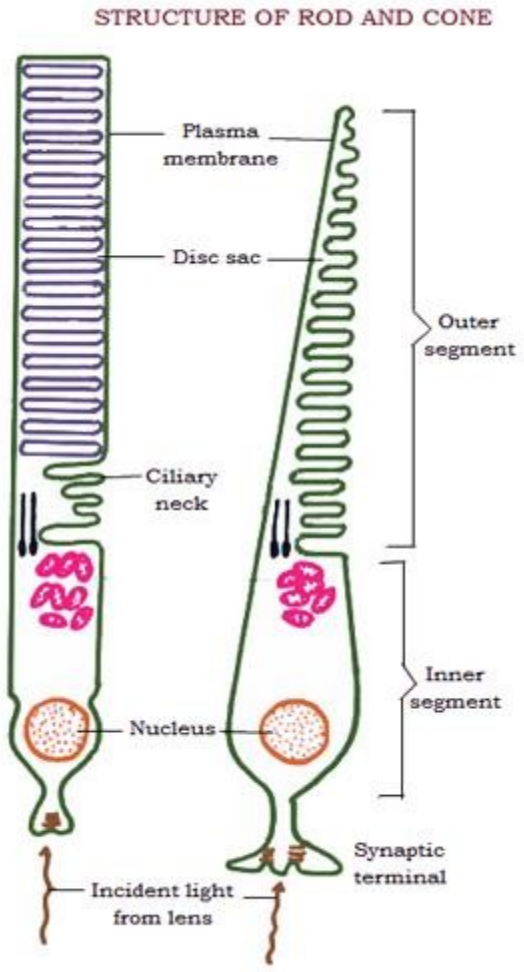
neuroepithelium, the pars optica retinae. This terminates around the ciliary body where it ends in a regular circular line, the ora ciliaris retinae (ora serrata in man). Hereafter, the retina loses its nervous elements. The part of the retina over the ciliary body is the pars ciliaris retinae and that over the iris is the pars iridica retinae. Pars iridica retinae are a layer of pigmented cells that covers the posterior surface of the iris. The area centralis retinae is a rounded spot situated above the optic papilla and corresponds to the macula lutea of man. The entrance of optic nerve forms a definite oval area -the optic papilla or blind spot. The optic nerve fibres converge from all parts of the pars optica to the papilla, where they collect into bundles that traverse the lamina cribrosa of the chorioid and sclera, and constitute the optic nerve.

- The pars optica retinae is that part of the eye which transforms the stimulus of light into nerve impulses, resulting in the sensation of vision. Embryologically, the retina arises from the two layers of ectoderm that form the optic cup. The outer layer gives rise to the pigment epithelium; the inner layer forms the remainder of the retina. In pathological detachment of the retina, or as generally occurs in the fixed and preserved specimens, the primary embryonic cavity between the two layers become reformed and the two parts of the retina gets separated, the pigment epithelium remaining adherent to the chorioid. The strictly nervous portion is firmly attached to the underlying structures at only two regions, at the ora ciliaris retinae and at the optic disc. The retina detached from the pigment epithelium is a thin, delicate membrane, which in life is transparent.

STRUCTURE OF RETINA

- **Structure**: Histologically the retina consists of ten layers, except at the optic disc, optic papilla, the area centralis and extreme periphery. These layers from without inward are:
    - Pigment epithelium.
    - Layer of rods and cones.
    - External limiting membrane.
    - Outer plexiform (molecular or synaptic) layer.
    - Inner nuclear (granular) layer.
    - Inner plexiform (molecular or synaptic) layer.
    - Ganglion cell layer.
    - Nerve fibre layer.
    - Internal limiting membrane.
- The **pigment epithelium** is a single layer of nearly cuboidal cells, broad and hexagonal in surface view. The *outer portion* of the cell contains a spherical nucleus with a moderate amount of rounded pigment granules. The *inner portion* filled with dark needle shaped pigment granules, which also extent into fine cytoplasmic processes arising from the inner surface of the cell and reaching down between the outer membranes of the visual cells. The melanin pigment here is a known as **fuscin.**
    - The nature and significance of the remaining layers of the retina will be understood if it is realized that the stratification depends upon the location of three sets of neurons and their relation to each other. These neurons, together with certain supportive elements of ectodermal origin make up the bulk of the retina. Considering them in the order of their conduction of nerve impulse, we find that the *first neuron* is represented by the **photoreceptors**, the **rod** and **cone cells**. These form not only the layer of that name but also the *outer nuclear layer* that consists of the nuclei and much reduced cell bodies of the neurons. From each cell a fibre is continued inward in the *outer plexiform layer*, where it makes a synaptic junction with the dendrite of a second neuron, the **bipolar cell.** The nuclei of the bipolar cells lie in the *inner nuclear layer*; their axons pass inward to make up the *inner plexiform layer*, where they effect synapse with the dendrites of the **ganglion cells**. The relatively large cell bodies of the latter form the *ganglion cell layer;* their long axons course in the *nerve fibre layer* to the optic disc, where all the axons converge to form the **optic nerve**. Thus the retina consists mainly of layers of nerve cells alternating regularly with layers formed by their processes. It is further evident that the true receptors, the rods and cones lie further most removed and turned away from the light stimulus, which is to affect them must pass through all the intervening layers (except at the centre of area centralis retinae). Thus the retina is an upside-down organ. The inverted retina is characteristic of all vertebrates.
    - In addition to nerve cells certain supportive elements, the supporting fibres of Muller, contribute to the formation of several layers.

- **Layer of rods and cones** lies between the external limiting membrane and the pigment epithelium, facing the latter. The *rods and cones* or *visual cells* are the outer light sensitive portions of this layer arranged in parallel fashion, perpendicular to the surface.
    - **Rods:** These are long and slender. Each rod shows an *outer* and an *inner segment*. The *inner segment* is slightly thicker. From the inner end of the inner segment, a slender filament passes as the rod fibre through the external limiting membrane to the outer nuclear layer. Here it enlarges to accommodate the nucleus and is then continued as a fibre into the outer plexiform layer. The retina from the dark-adapted eye appears purplish red. This colour is due to **rhodopsin** or **visual purple** in the outer segments of the rod. This visual purple bleaches in light and regenerates in the dark. Rods function under conditions of *low light intensities*.
    - **Cones:** The cones are bottle or flask shaped cells, which consist of *inner* and *outer segments*. The *outer segment* is small and conical. The *inner segment* has a bulbous form. The inner segment is continuous with the cone fibre that passes through the external limiting membrane. Just under this membrane the fibre enlarges to include the nucleus and is then continued as a slightly short fibre into the outer plexiform layer. Cones function under *high intensities of illumination* and are responsible for *colour vision*.



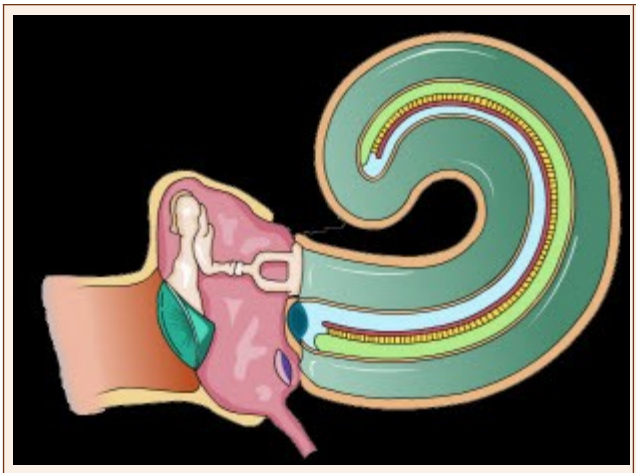
- **External limiting membrane**: This is a thin sieve-like membrane formed by the Muller's fibres.
- **Outer nuclear layer**: It appears to consist solely of the nuclei of the visual cells. However, a delicate mantle of cytoplasm can be made out around each nucleus. The *rod nuclei* are smaller, round in shape and stain intensely. The *cone nuclei* are slightly larger, oval in shape and stain less intensely. The cone nuclei are situated close to the external limiting membrane.

- **Outer plexiform layer:** It is consists of the meshwork formed by the terminal fibres of rods and cones and the arborizations of the dendrites of the bipolar cells. The fibres of several rods are here related to the dendrite ending of one bipolar cell. In the case of cones, however a single cone fibre is associated with a single bipolar cell.
- **Inner nuclear layer:** It is thinner than the outer nuclear layer but is similar in appearance. It contains the nuclei of bipolar cells, certain association neurons and the nuclei of**Muller's fibre**. The association neurons are the **horizontal** and **amacrine cells**; they serve to interconnect the various regions of the retina. The nuclei of this layer arranged in three zones: an outer one or *horizontal cell nuclei*, middle one or *bipolar cell nuclei* and an inner one in which the *nuclei of amacrine cells* predominates.
- **Inner plexiform layer**: This consists of the processes of amacrine cells, the axons of bipolar cells and the profusely branched dendrites of ganglion cells.
- **Ganglion cell layer**: It is composed of single layer of typical multipolar ganglion cells, among which are scattered neuroglia cells. Branches of regional blood vessels are also seen.
- **Nerve fibre layer:** It consists of the axons of ganglion cells. The non-medullated fibres are arranged in bundles, which run parallel to the surface of the retina and converge at the optic papilla to form the optic nerve. Between these bundles, rows of Muller's fibres and retinal blood vessels also pass.
- **Internal limiting membrane:** It is a thin membrane of hyaline nature, formed by the opposition of expanded bases of Muller's fibres. It separates the retina from the vitreous body.
- ***Blood supply****:* Central artery of retina

REFRACTIVE MEDIA OF THE EYE

- The refractive media include the *cornea,* the *aqueous humor* in the anterior and in posterior chambers, the *lens* and the *vitreous humor*.
- The **cornea** is described earlier in the fibrous tunic.
- The **aqueous humor** is a clear fluid of an alkaline reaction, consisting chiefly of water with a trace of albumin and chloride or sodium. It fills the anterior and posterior chambers of the eyeball.
  The **anterior chamber** is the space in front by the cornea and behind by the anterior face of the iris and the central part of the lens. The **posterior chamber** is a narrow space bound by the posterior surface of the iris infront, and the circumference of the lens, its ligaments and ciliary process behind. The two chambers communicate freely with each other through the pupil.
- The **crystalline lens** is a biconvex transparent body that is situated in front of the vitreous body and in partial contact with the posterior face of the iris. The *periphery* or*equator* of the lens is almost circular and is surrounded by the ciliary processes. The *anterior face* is convex and the *posterior face* is much more convex and rests in the fossa hyaloidea of the vitreous body. Three structural components make up the lens are **capsule**, **anterior epithelium**, **lens substance**. It is enclosed in a capsule (lens capsule) that is attached by the suspensory ligament to the ciliary processes.
  The **anterior epithelium** is a single layer of cuboidal cells on the anterior surface under the capsule. There is no **posterior epithelium** as these cells have given rise to the primitive lens fibres during development. At the equator, the cells are arranged meridionally in rows. This is the region where new lens fibres are formed constantly. The central points of the surfaces of the lens are anterior and posterior poles and the line that connects them is the axis of the lens. The **lens substance** consists of concentric lamellae of lens fibres that are colorless and transparent. It is enclosed by a structureless highly elastic membrane, the**capsule** that consists of a softer cortical substance and a dense central part, the nucleus of the lens. The lens substance when hardened is seen to consist of concentric lamellae of lens fibres united by an amorphous cement substance. The lens is devoid of vessels and has no nerves.
- The **vitreous humor** is the transparent jelly situated behind the lens and between it and the retina. In front, it presents a deep fossa -**fossa hyaloidea** for the lens and is enclosed by the hyaloid membrane a condensation of the stroma. It composed of jelly like connective tissue, the meshes of which are filled by fluid -vitreous humor.

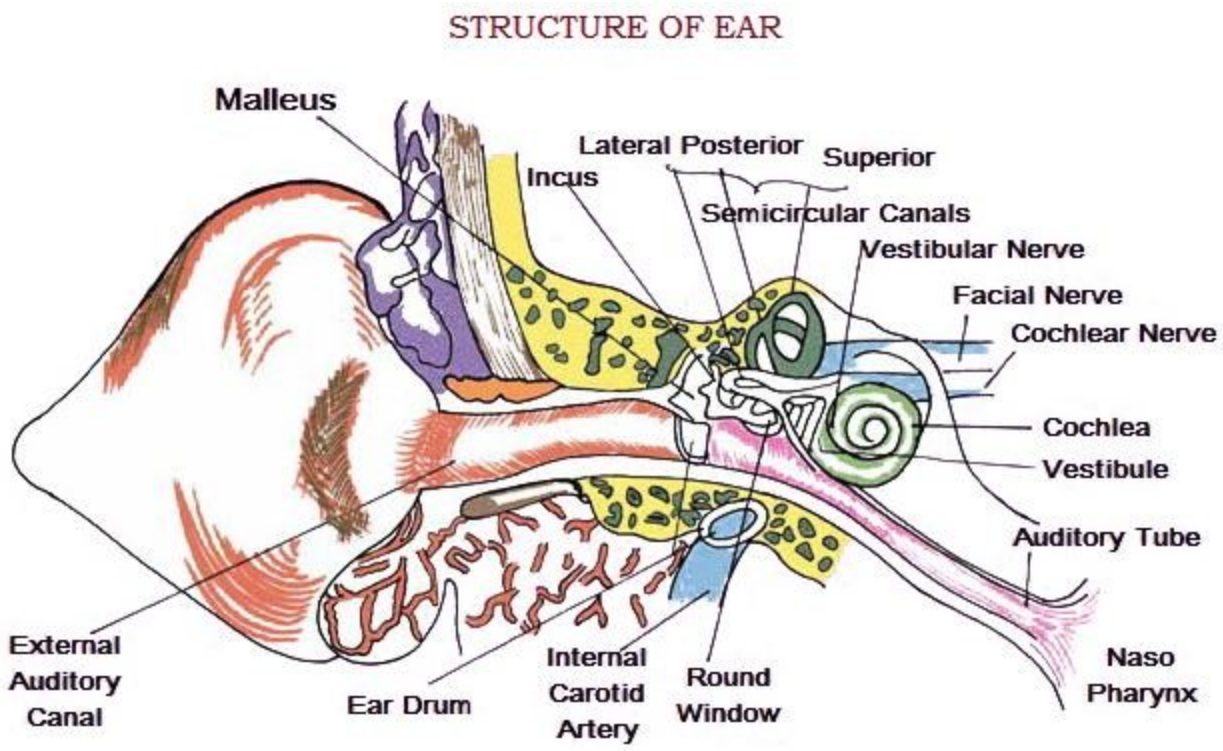
MODULE-34: ORGAN OF HEARING - EAR



LEARNING OBJECTIVES

- To study the companents of external, middle and inner ea in detail.
- To have a better understanding on the mechanism of hearning.
- It will help the clinician to examine the different parts of ear and to test the auditory reflexes and also for surgical approaches to the ear.

EXTERNAL EAR



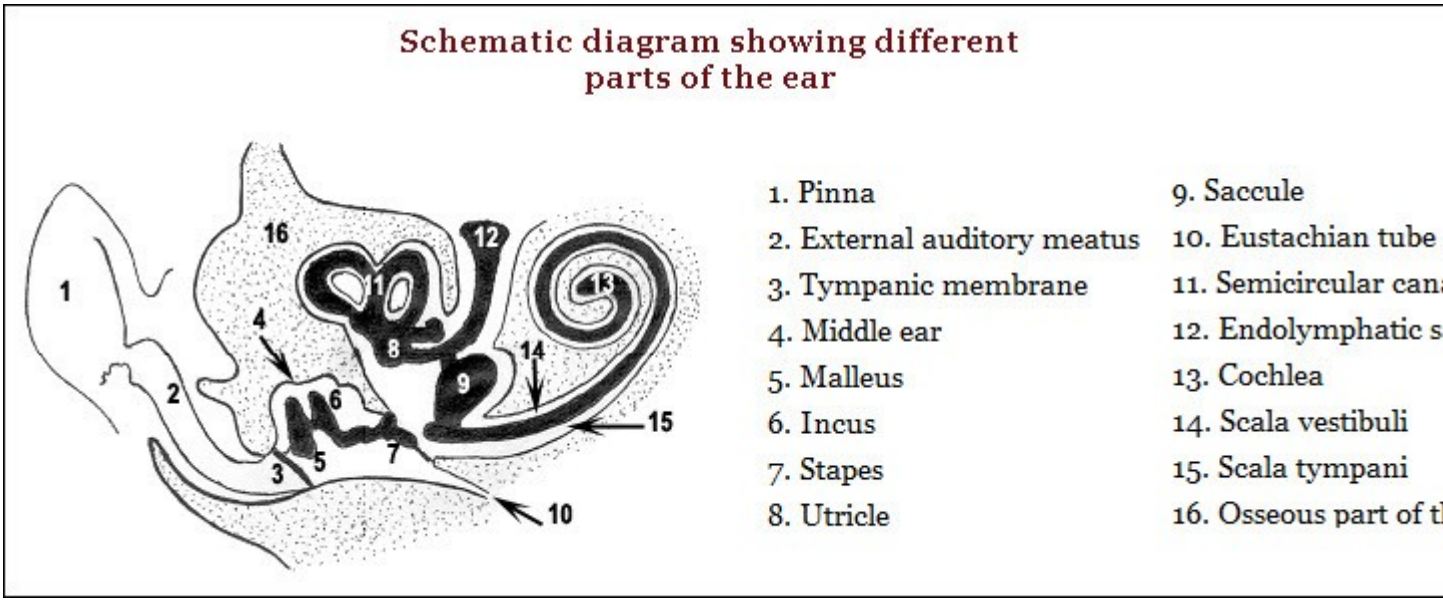
- The external ear consis of two parts, the auricula or pinna - a funnel shaped organ with its muscles, which collects the sound waves and the external acoustic meatus, which conveys these waves to the drum of the ear which separates the external ear from the middle ear.
- The auricula or pinna is the visible ear, has two surfaces, two borders, base and an apex.
- The anterior surface is irregularly concave and presents an opening of the external ear.
- There are three or four ridges and two or three furrows, which become gradually effaced towards the extremities.
- The posterior surface is convex and presents grooves and elevations corresponding to those on the anterior surface.

- This surface is almost circular at the base and flat and narrow at the extremity.
- The middle portion forms the widest part. The superior border in convex.
- The inferior border is thicker and more strongly convex.
- The base is convex and is attached to the external auditory process of the petrous temporal bone in such a way as to be freely movable.
- It is surrounded by a flat in its anterior, internal and posterior aspects.
- Its inferior and external parts are overlapped by the parotid gland.
- The auricula is made up of elastic cartilages, muscles and skin.
- The cartilages of the external ear are conchal, annular and scutiform.
    - The conchal cartilage determines the shape of the ear. The base of the cartilage is coiled to from a tube that encloses the cavum conchae that is funnel shaped. Its medial surface is convex and bears a prominence the eminentia conchae. The lower part of the medial margin bears a pointed prolongation -the styloid process. Behind the base is a foramen for the auricular branch of the vagus.
    - The annular cartilage is a quadrilateral plate curved to form three fourth of a ring and it embraces the external acoustic process. It forms with the lower part of the conchal cartilage and the cartilaginous part of the external acoustic meatus.
    - The scutiform cartilage is a quadrilateral piece situated in front of the base of the concha. Its superficial face is convex from side to side and deep face is concave. Its anterior end is thin and rounded and posterior end is thicker and wider and it gives attachment to the muscles. The cartilage moves freely over the underlying parts.
- The auricular muscles have already been described under myology.
- The external acoustic meatus leads from the cavum concha to the tympanic membrane. Its direction is downwards, forwards and inwards.
- It consists of a cartilaginous part and osseous part.
- The annular cartilage forms the cartilaginous part while the external acoustic process of the temporal bone forms the osseous part.
- These are united by elastic membranes to form a complete tube.
- Its lumen at the inner end is one half of that at the outer end.

MIDDLE EAR

- The middle ear comprises the tympanic cavity or tympanum with its contents and the eustachian tubes.
- The tympanum is the cavity excavated in the bulla tympanica of the petrous temporal bone. It is situated between the tympanic membrane and internal ear.
    - It is a laterally com- pressed air cavity lined by mucous membrane and communicates with the pharynx by the eustachian or pharyngo-tympanic tube.
    - The cavity presents a main part the atrium, which lies medial to the tympanic membrane and a recessus epitympanicus, which lies above the level of the tympanic membrane, containing the upper part of the malleus and a greater part of the incus and a larger recess below the bulla tympanica.
    - The cavity has six walls and the atrium communicates ventrally with the air cells of bulla tympanica.
    - The roof or tegmental wall is crossed in its medial part by the facial nerve as the facial canal is deficient below and the nerve is covered by mucous membrane.
    - The floor is concave and thin.
    - It is crossed by delicate curved ridges that radiate from the annulus tympanicus.
    - The anterior or tubal wall is narrow and is pierced by the slit-like opening of the eustachian tube. The posterior wall presents no special features.
    - The lateral wall is formed by the membrana tympani, which closes the medial end of the external acoustic meatus and thus forms a septum between the external and middle ear. It is an oval disc that slopes downwards and inwards.
    - The circumference of this is attached in a groove -the sulcus tympanicus in a thin ring of bone the annulus tympanicus that completely surrounds it.

- The handle of the malleus is attached to the internal face of the membrane and draws the central part inward, producing a slight concavity of the outer surface.
- The periphery of the membrane is thickened by fibrous tissue, annulus fibrosus.



- The tympanic membrane or ear drum is semitransparent and consists of three layers
  - Outer thin cutaneous layer
    - Outer thin cutaneous layer, a prolongation of the lining of external acoustic meatus
  - Middle fibrous layer
    - Middle fibrous layer the membrana propria consisting of two sets of fibres, external radiating from the handle of malleus and internal circular
  - Internal mucous layer
    - Internal mucous layer, a part of the mucous membrane lining the tympanic cavity. The medial or labyrinthine wall separates it from the internal ear.
- The promontory is a distinct eminence near the centre, which corresponds to the first basal coil of cochlea, and is marked by a faint groove for superficial petrosal nerve.
- Above and behind the promontory it presents a reniform opening the fenestra vestibule (oval window), which is closed by the footplate of stapes.
- The fenestra cochleae (round window) an irregularly oval opening is below and behind it and is closed by the secondary tympanic membrane which separates the tympanum from the scala tympani of the cochlea.
- The facial nerve runs along the medial wall in a canal immediately above the fenestra vestibuli. This canal is immediately above the fenestra vestibuli and causes a prominence.
- The auditory ossicles form a chain of bones extending from the lateral to the medial wall of the cavity.

- These from without inward are Malleus, Incus and Stapes.
  - The malleus (hammer) has a head, neck, handle (manubrium) and two processes. The head lies in the attic or recessus epitympanicus and presents posteromedially a facet for the incus. The handle is attached to the membrana tympani.
  - The incus (anvil) has a body and two processes. The body articulates with the malleus while the long process has attached to it the os lenticulare, which is a small nodule of bone articulating with the stapes.
  - The stapes (stirrup) has a head, two crura and a base. The head meets os lenticulare and the base is attached to the fenestra vestibuli.
- **Muscles:** The tensor tympani and stapedius muscles consist of skeletal muscle fibres.

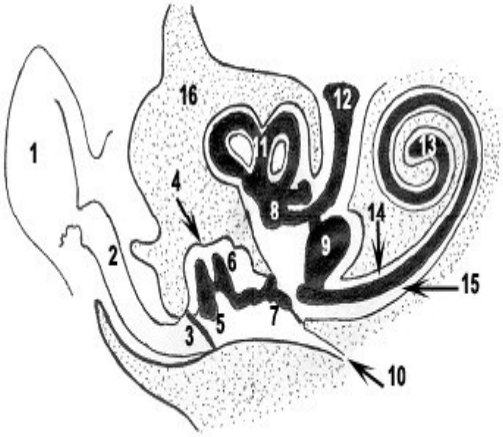
- The tensor tympani lies for the most part in a canal just above the auditory tube in the anterior wall of the tympanic cavity.
- It ends in a tendon, which bends sharply around the end of a bony canal and passes laterally across the tympanic cavity to be inserted to the manubrium inward and thus makes the tympanic membrane tense.
- The stapedius muscle lies within a small conical bony projection the pyramidal eminence on the posterior wall of the tympanic cavity.
- Its tendon passes through a minute aperture in the summit of the eminence and is inserted into the posterior surface of the neck of stapes.
- Besides the muscles, there are several ligaments.
- The chorda tympani nerve passes across the tympanic cavity its entire lateral wall directly over the manubrium of the malleus.
- Lining the tympanic cavity and investing all the structures contained within, is a membrane, the tympanic mucosa.
- This consists of a thin connective tissue propria covered by a simple squamous epithelium in the ventral portion of the tympanic cavity and on the tympanic membrane the auditory ossicles and the secondary tympanic membrane.
- The rest of the cavity is lined by ciliated columnar epithelium.
- The Eustachian (pharyngotympanic) tube extends from the tympanum to the pharynx.
- It is about 2 inches long. Its upper end is at the medial aspect of the root of the styloid process of petrous temporal and it communicates with the anterior part of the tympanic cavity by a small slit like opening. It consists of bony and cartilaginous parts.
- The tube is complete for about an inch and its lumen is a capillary space, this is the bony part.
- Further downwards it is a groove and is completed below by cartilage.
- Pharyngeal opening is small and is on the superoposterior part of pharynx close to the base of cranium.
- The mucosa bears pseudostratified ciliated epithelium containing goblet cells.

INTERNAL EAR

- It is the essential part of the organ of hearing and receives peripheral ramifications of the auditory nerve.
- It is also called as labyrinth due to its complexity of its shape.
- It consists of two parts,
    - a complex membranous sac containing neuroepithelium filled with a fluid endolymph, the membranous labyrinth
    - a series of cavities in the petrous temporal bone encloses membranous part, the osseous labyrinth.
- The two parts being separated by perilymphatic space containing a fluid the perilymph.

OSSEOUS LABYRINTH

Schematic diagram showing different parts of the ear



1. Pinna
2. External auditory meatus
3. Tympanic membrane
4. Middle ear
5. Malleus
6. Incus
7. Stapes
8. Utricle
9. Saccule
10. Eustachian tube
11. Semicircular canal
12. Endolymphatic sac
13. Cochlea
14. Scala vestibuli
15. Scala tympani
16. Osseous part of the ear

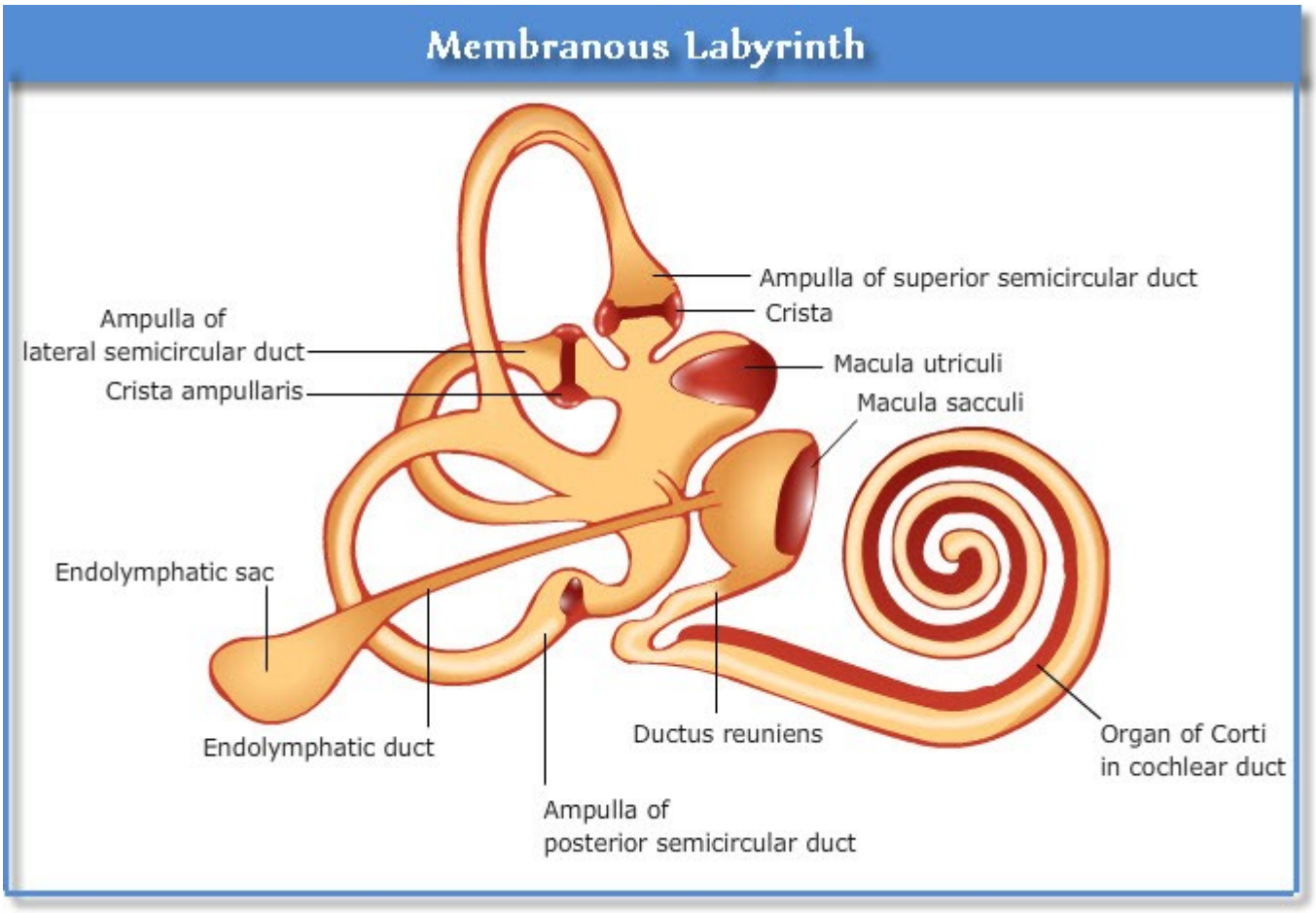
- The **osseous labyrinth** is excavated in the petrous part of the petrous temporal bone, medial to the tympanic cavity. It consists of three parts -a middle *vestibule*, an anterior*cochlea* and posterior *semicircular canals*.
- The **vestibule** with the cochlea in front and semicircular canals behind. It is 5 to 6 mm. long. Its *lateral wall* separates it from the tympanic cavity and in it are the **fenestra vestibuli** and **fenestra cochleae**. Its *medial wall* corresponds to the fundus of internal acoustic meatus. Internally it is crossed by an oblique ridge the **crista vestibuli**, which separates the two recesses,
- an anterior smaller recess - **recessus sphericus**, lodging the saccule and a posterior larger depression - **recessus ellipticus** lodging the utricle. The two diverging branches of crista vestibuli below include between them the small recess- **recessus cochlearis**. The recessus have number of minute foramina for passage of nerve fibres to the saccule, utricle, semicircular ducts and cochlear duct. The *posterior part* presents the four openings of the three semicircular canals. The *anterior part* of the vestibule shows an elliptical opening leading into the scala vestibuli of the cochlea. The orifice of the aqueduct of the vestibule lies below the recessus ellipticus. The aqueduct extends to the posterior portion of the petrous temporal bone; it transmits a vein and contains a tubular prolongation of the membranous labyrinth that is termed the **ductus endolymphaticus**.
- The **semicircular canals** are three in number and are behind and above the vestibule. Each canal is about two thirds of a circle, one end of which is slightly enlarged to form the **ampulla**. They are at right angles to each other and are designated **dorsal, posterior** and **lateral**. They communicate with the vestibule by four openings, as the inner end of the dorsal and the upper end of the posterior unite together and the ampullated ends of dorsal and lateral have a common orifice. The dorsal and posterior canals are nearly vertical and the lateral canal is horizontal.

- The **bony cochlea** resembles snail-shell and forms anterior part of the bony labyrinth. It is in the form of a blunt cone the base of which corresponds to the anterior part of internal acoustic meatus and the **apex** or **cupola** is directed outward, forward and downward. It consists of a **spiral canal** that forms two and half runs around a bony process, the **modiolus**. The modiolus is a conical shaped central axis. Projecting from the latter like the thread of a screw is a thin plate of bone, the **lamina spiralis** that extends about halfway into the canal thus dividing it incompletely into two passages an upper **scala vestibuli** and a lower **scala tympani**. In life, a membrane, the**membrana basilaris** extends from the free margin of the lamina to the lateral wall of the cochlea and thus completes the two scala but they communicate through an opening at the apex called **helicotremma**. The modiolus is traversed by an axial canal extending from the base to the apex and a spiral canal is present along the attached border of lamina spiralis.
- The base of the cochlea shows three openings:

- The **fenestra cochleae** which communicates with the tympanic cavity and in recent state is closed by the secondary tympanic membrane.
- An **elliptical opening** to the vestibule.
- The **aperture of the aqueduct of cochlea** leading to a minute funnel shaped canal, which opens into the ventral surface of the petrous part of the temporal bone. It transmits a small vein to join the ventral petrosal sinus and also establishes communication between the subarachnoid space and the scala tympani.

MEMBRANOUS LABYRINTH

- This consists of a series of interconnected sacs and ducts lying within the osseous labyrinth. The membranous labyrinth has nearly the same general form as the osseous part but does not fill it completely, being considerably smaller in diameter. It is separated from the wall of bony labyrinth and is surrounded by perilymph but is anchored by connective tissue trabeculae extending from the membranous part to the bony wall at certain points. The various parts of the membranous labyrinth are interconnected and form a closed system containing a fluid known as **endolymph**.
- The membranous labyrinth consists of four parts utricle, saccule, three semicircular ducts and cochlear duct. .
- 1. The **utricle** is the larger of the two sacs and lies in the superoposterior part of the vestibule, in contact with the elliptical recess. It receives the openings of the semicircular ducts and opens anteromedially into a small **ductus utriculosaccularis**. The lateral wall of the utricle shows a thickened area the **macula utriculi**, which is lined by neuroepithelium.
- 2. The **saccule** is the smaller spherical sac located in front of the utricle, occupying the spherical recess of the vestibule. The anterior wall of the saccule shows a thickening, the**macula sacculi**, which is lined by neuroepithelium. View animation...
- 3. The **semicircular ducts** correspond to the osseous semicircular canals and fill up only one fourth of the lumen of the bony canals except at the ampullae, where they fill up the entire canal. In each of the ampulla the wall is thickened and projects as transverse elevation, the crista ampullaris containing neuroepithelium.
- 4. **Cochlear duct (Scala media)**: The bony cochlea is incompletely divided by osseous spiral lamina into an upper **scala vestibuli** and lower **scala tympani**. A**membrana basilaris** extends from the osseous spiral lamina to the lateral wall of bony cochlea to complete this division. The lateral wall is lined by thick fibrous tissue called the **spiral ligament**. Another membrane, the **vestibular** or **Resissner's membrane** extends from above the osseous spiral lamina, outwards and upwards to the lateral wall of the cochlea. A canal is thus formed which is triangular in section between the vestibular membrane above; spiral ligament laterally and the membrana basilaris below. This is termed as the **cochlear duct**. Its origin in the basal coil of the cochlea is blind but immediately after its origin it is connected to the saccule by the **ductus reunions**. The cochlear duct traverses through the bony cochlea and terminates blindly at the cupola, to which it is attached. The cochlear duct contains endolymph.



- The **scala vestibuli** contains perilymph and opens into the vestibuli and is in close relation to the oval window or fenestra ovalis.
- The **scala tympani** is in communication with scala vestibule at the apex of the cochlea through a small canal, the **helicotremma** but at the base, it ends against the **round window** or **fenestra rotundum**, which is closed by the secondary tympanic membrane. Extending from the scala tympani is the **perilymphatic duct** that passes through the aquaeductus cochleae and opens at the ventral margin of petrous temporal bone into the subarachnoid space in the cranial cavity.
- The **auditory** or **eighth cranial nerve** divides at the bottom of the internal auditory meatus into *cochlear* and *vestibular divisions*. The **vestibular nerve** close to the meatus presents the vestibular ganglion. The peripheral processes of the bipolar cells in the ganglion are distributed to the macula of the utricle and crista ampullaris of the semicircular ducts. A separate branch ends on the macula sacculi. The **cochlear nerve** passes though the axial canal in the modiolus and fibres end in a series of bipolar cells in the spiral canal in the osseous spiral lamina, which form the spiral ganglion. The peripheral processes of the cells in the spiral ganglion pass through openings on the tympanic lip of osseous spiral lamina and end on the hair cells of the organ of corti on the membrana basilaris.

MICROSCOPIC STRUCTURE OF THE MEMBRANOUS LABYRINTH

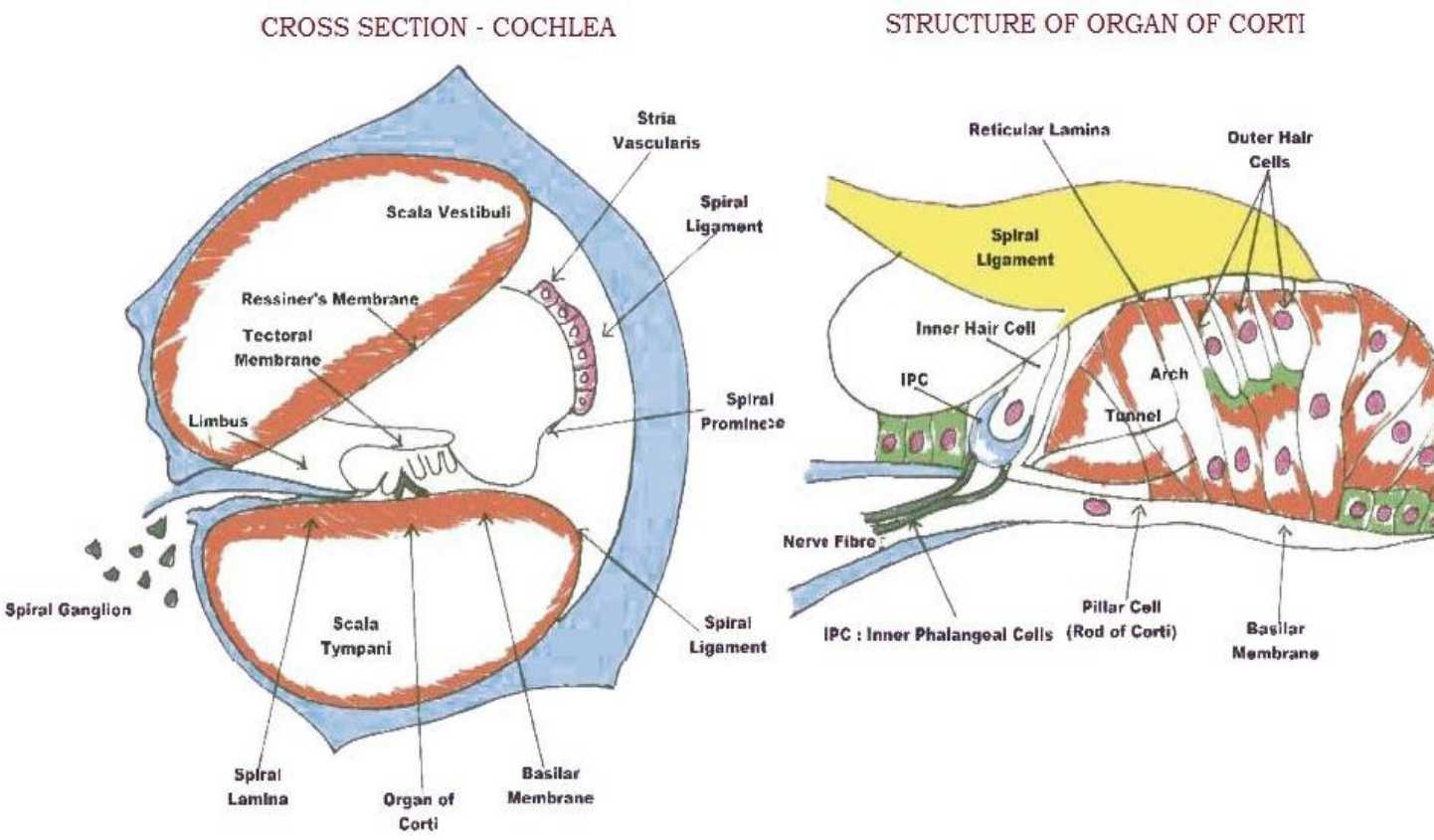
- The walls of the membranous labyrinth are made up of outer thin tunica propria and an inner lining epithelium. The tunica propria is composed of delicate fibrous tissue and stellate fibroblasts. The epithelium of the membranous labyrinth is a single layer of flat squamous cells resting on a basement membrane.

- In certain regions, the wall of the membranous labyrinth is considerably modified and is lined by neuroepithelium. These are the **macula utriculi**, **macula sacculi**, the**crista ampullaris** and the **organ of Corti**.
- **Maculae**: These represent local thickenings of the membranous wall in the *utricle* and *saccule* forming an elevation into the endolymphatic space. The epithelium is columnar type in which two kinds of cells may be distinguished, the *sustentacular* and *hair cells*. The tunica propria in the macular region is firm, thickened and is closely united to the underlying periosteum of the bony vestibule.
    - The **sustentacular** or **supporting cells** are tall columnar elements resting on the basement membrane. Their basal portions containing the oval granular nuclei and are broader than their upper portions that pass between the hair cells. The free surface of each sustentacular cell bears a cuticular plate. At the edge of the macula, the sustentacular cells show a gradual transition into the simple squamous epithelium characteristic of the remainder of membranous labyrinth.
    - The **hair cells** occupy the outer part of the epithelium. Each hair cell has the shape of rounded flask. The large, oval and deeply staining nucleus lies towards the base of the cells. The free surface is covered by cuticular plate, through which passes a single long tapering process the so called **hair** of the hair cells. The hair is made of fine nonmotile cilia. The hairs penetrate a membrane called the **otolithic membrane**, consisting of a gelatinous substance containing a number of small bodies, the **otoconia** or **otoliths**. The otoconia are made of calcium carbonate.
    - The hair cells are intimately related to the fibres of vestibular nerve. The fibres enter the tunica propria of the macula, lose their myelin sheath and the naked axis cylinders pass through the basement membrane and terminate around the hair cells. The maculae are concerned with static equilibrium i.e., the position of head in space in relation to gravity.
- **Crista ampullaris:** Each crista ampullaris is thickened to form a ridge, placed transversely to the long axis of the duct. The ridge consists of connective tissue propria containing many nerves and blood vessels and surmounted by a specialized columnar epithelium. The columnar epithelium is similar to that of macula consisting of sustentacular cells and hair cells. In certain fixed preparations, the epithelium is surmounted by a tall rounded longitudinally striated mass, the **cupola**. The fibres of the vestibular nerve terminate in the epithelium of the crista in the same manner as in the macula. The cristae ampullaris are supposed to be concerned in dynamic equilibrium. They are stimulated by movements, which involve any amount of rotation.

- **Cochlear duct:** The wall of the bony cochlea is lined by a thin periosteal connective tissue covered by mesenchymal epithelium in the two scalae. The **vestibular membrane**is thin and homogeneous and is covered on its two surfaces by a layer of flattened epithelium. The periosteum forming the outer wall of the cochlear duct called the **spiral ligament** is greatly thickened and projects inwards as a triangular prominence termed the **crista basilaris** to which the outer edge of the basilaris membrane is fixed. Immediately above this there is concavity termed the **sulcus spiralis externus**, above which the periosteum contains numerous blood vessels and is termed the **stria vascularis**. It is believed that the stria vascularis secretes the endolymph of the cochlear duct.
- The **osseous spiral lamina** consists of two plates of bone and between these are the bipolar cells of the spiral ganglion. Minute canals pass outwards between the two plates leading to openings in the tympanic lip of the spiral lamina, through which the peripheral processes of the nerve cells from spiral ganglion pass to the organ of Corti on the basilar membrane.
- The **basilar membrane** stretches from the tympanic lip of the osseous spiral lamina to the crista basilaris. It supports the spiral organ of Corti. The basilar membrane consists of fine straight, unbranched fibres and the **basilar fibres** or **auditory strings** embedded in a sparse, homogeneous ground substance. The breadth of basilar membrane varies in the different turns of the cochlea. It is greatest at the apex, gradually diminishing towards the base until its narrowest extent is reached in the proximal end of the basal coil.

MICROSCOPIC STRUCTURE OF THE MEMBRANOUS LABYRINTH

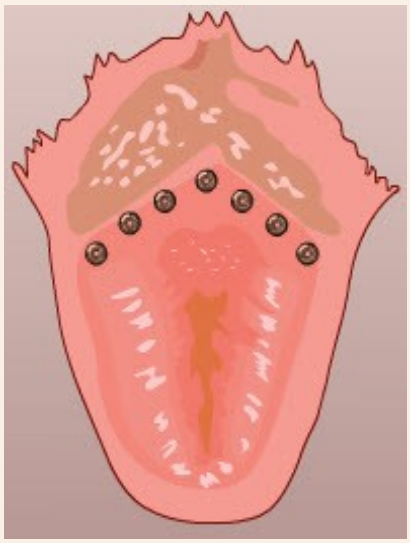
- The **spiral organ of Corti**: It is composed of a series of epithelial cells placed upon the basilar membrane projecting into the endolymph of cochlear duct. It extends through the entire length of the cochlear duct with the exception of a short distance at either end. Named in their order from within outwards the following specialized cell types comprise the organ of corti.
    - The border cells.
    - The inner hair cells.
    - The inner phalangeal cells.
    - The inner and outer pillar cells (inner and outer rods)
    - Outer phalangeal cells (cells of Dieters).
    - Outer hair cells.
    - Cells of Hensen.



- The Hensen cells are continuous with the **cells of Claudius**, which are cubical and extend over the remainder of the basilar membrane to the spiral ligament. All except the hair cells may be considered as **sustentacular** or **supporting cells**. The hair cells are intimately related to the endings of the cochlear nerve and are neuroepithelial cells.
- 1. The **border cells** and **cells of Hensen** are slender columnar cells which rest on the basilar membrane and are arranged in the inner and outer aspects of the hair cells.
- 2. The **hair cells** are columnar cells. The free surface of each has short stiff hairs, which are in contact with the tectorial membrane. Their rounded basal ends rest on the phalangeal cells. The inner hair cells form a single row while the outer hair cells are arranged from 3 rows in the basal coil to 5 rows in the apical coil. The hair cell is arranged on either side of the inner and outer pillar cells or rods of corti.
- 3. The **phalangeal cells** are arranged below the hair cells in corresponding number of rows. Their bases rest on the basilar membrane and their upper borders are concave and on these rest the lower ends of hair cells. The nucleus is located in the basal part of the cells and from the upper part of the cell a slender process passes between the hair cells to the surface and ends in a cuticular plate.

- 4. The **pillar cells** or **rods of Corti**: These are inner and outer rods or pillar cells and are modified columnar cells with a broad basal part with nucleus rests on the basilar membrane and an **elongated body** or **pillar**, which ends at the free upper extremity in an enlarged head. The bases of the inner and outer pillar cells are farther apart but their heads converge and articulate with each other. Thus a triangular tunnel of Corti is formed between the two pillar cells and the basilar membrane.
- **Tectorial membrane:** Above the cells of the organ of corti and lying in contact with the hair cells in life is a thick, elongated gelatinous structure called the **tectorial membrane**. It is usually distorted during fixation. It begins at the inner angle of the cochlear duct as a thin layer attached to the epithelial surface on the thickened periosteum over the osseous spiral lamina (**limbus spiralis**). Farther outward, the membrane becomes thicker with a pronounced convexity on its upper surface and its lower surface is in contact with hair cells of the organ of corti. Beyond this, it becomes thinner and ends in a rounded tip.
- **Nerve fibres** : The peripheral processes of the bipolar cells of the spiral ganglion, pass through the tympanic lip of the spiral lamina and reach the organ of corti. Some of the fibres end on the inner hair cells, while others pass across the tunnel of corti and end on the outer hair cells. The nerve fibres form fine plexuses around the bases of the hair cells and terminate on button like endings in contact with the surfaces of hair cells.
- **Functions**
- **Cochlea**: The organ of corti in the cochlea is the receptor for the *sense of hearing*. Vibrations transmitted from the tympanic membrane through the chain of auditory ossicles reach the **fenestra ovalis** and **perilymph**. It is believed that the vibrations of the basilar membrane caused by those in perilymph stimulate the hair cells. The vibrating hair cells are in contact with the tectorial membrane through their hairs. The stimuli are conveyed through the spiral ganglion and the eighth cranial nerve to the brain. (For further pathways see neurology)
- **Vestibule** : The receptors in the macula utriculi and crista ampullaris are stimulated by alterations of the position of head and the impulses (equilibrator or vestibular) are concerned with the *maintenance of equilibrium of the body under various conditions*.

MODULE-35: ORGAN OF SMELL, TASTE, TOUCH AND SKIN



LEARNING OBJECTIVES

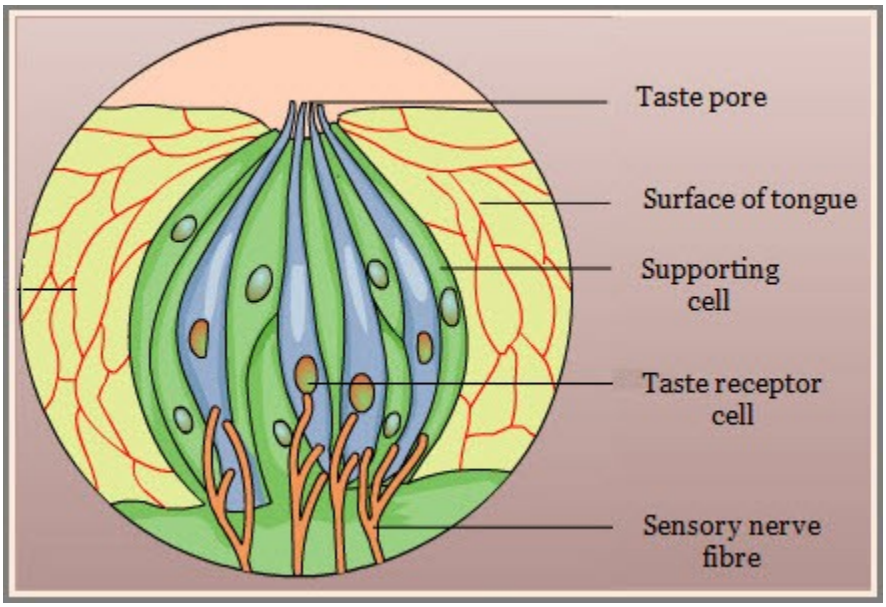
- To learn about the olfactory apparatus and gustatory apparatus.To understand the mechanism of olfaction and taste.
- It will help the clinician to examine the nasal cavity and oral cavity to diagnose the affections of the two apparatus
- To study in detail the structure of skin and its appendages such as hoof, horn etc.
- To study about the hoof structure and sensitive laminae.
- It will help in examining the hoof is racing animals and for certification of soundess of animals especiaaly horses.
- To study the species difference in domestic animals.

ORGAN OF SENSE

- The sense of smell is carried through the olfactory nerve, which is distributed on the nasal mucous membrane and covers the upper-fourth of the turbinate bones, septum nasi, nasal meatuses and ethmoidal cells called olfactory area.
- This part of the mucous membrane is pale-yellow in colour and is lined by epithelial cells.
- The epithelium is pseudostratified columnar and is considerably thicker than that of the respiratory region. The surface cells are of two kinds
    - Sustentacular cells
    - Olfactory cells.
- The sustentacular cells are more numerous cells, each consists of three parts:
    - A superficial portion, which is broad and cylindrical and contains pigment and granules, arranged in longitudinal rows. The cells have well marked striated thickened borders, which unite to form the so called membrana limitans olfactoria.
    - A middle portion, which contains an oval nucleus. As the nucleus of these cells all lie in the same plane, they form a distinct narrow band, which is known as the zone of oval nuclei.
    - A thin filamentous process, which extends from the nuclear portion down between the cells of the deeper layers. This process is irregular and pitted by the pressure of the surrounding cells. It usually forks and apparently anastomoses with processes of other cells to form a sort of protoplasmic reticulum.
- The olfactory cells lie between the sustentacular cells. Their nuclei are spherical lie at different levels and most of them are more deeply placed than the sustentacular cells. From the nuclear portion of each cell a delicate process extends to the surface, where it ends in several minute hair like processes. From the opposite pole of the cell a longer process extends centrally which has a centripetal nerve fibre of one of the olfactory bulb. The olfactory cell is thus seen to be the bipolar nerve cell with a short peripheral and a long central process and is not a neuroepithelial cell but an analogue of spiral ganglion cell being only example of peripherally placed ganglion cell found in certain lower animals.
- The basal cells are placed between the nuclear parts of the olfactory cells and the basement membrane.
- These are small nucleated elements with irregular branching cytoplasm of which anastomoses with that of the neighboring basal cells and of the sustentacular cells to form the peculiar protoplasmic reticulum already mentioned.
- The basement membrane is not well developed.
- The stroma consists of loosely arranged collagenous fibres, delicate elastic fibres and connective tissue cells. Embedded in this stroma are numerous simple branched tubular glands, the glands of Bowman. Each tubule consists of a duct, a body and a fundus.
- The secretary cells are larger and irregular and contain a yellowish pigment, which with that of the sustentacular cells is responsible for the colour of the olfactory mucosa. View animation...

ORGAN OF TASTE

- The tongue is the organ of taste. It owes this property to the taste buds, which are situated in the foliate, fungiform and vallate papillae in the mucouse membrane of the tongue, the oral face of epiglottis and anterior pillars of soft palate.
- The taste buds are oval flask shaped masses, which occupy the recesses in the epithelium.
- The base of each taste bud is wider and rests on the corium of the mucous membrane.
- It receives a branch from the combined sensory nerve formed by the union of the chorda tympani of the VII nerve and the gustatory branch of the V nerve in the anterior two-thirds of the organ and from the lingual branch of the IX nerve if in the posterior-third.
- The apex of each bud is narrow and communicates with the mouth cavity by a small gustatory pore.
- Each bud presents a small opening towards the surface, the taste or gustatory pore.
- The taste bud consists of fusiform supporting cells grouped around central taste or gustatory cells.
- The taste cells are neuroepithelial cells. The external end of each taste cells bears a filament, the gustatory hair which projects through the gustatory pore.
- The internal end of the taste cells ends in a fine process, which may be single or branched.
- Taste buds are innervated by gustatory fibres of glossopharyngeal, facial and vagus nerves.



SKIN

- The skin or the common integument is the protective covering of the body and is continuous at the natural orifices with the mucous membranes of digestive, respiratory and urinogential tracts.
- It acts as a sense organ concerned with the reception of pain, temperature (warmth and cold), touch (coarse touch and tactile) and pressure sensations.
- There are various types of nerve endings in the skin, some in the epidermis, others in the dermis, around roots of hairs etc., which serve as the receptors for the above sensations. These include
    - Free nerve endings in the epidermis for plain.
    - Merkel's discs, Meissner's corpuscles, Peritrichial plexus etc, for touch and tactile sensations.
    - Ruffini's corpuscles for warmth and Krause's corpuscles for cold.
    - Pacinian corpuscles for pressure sensation.

SKIN APPENDAGES

- The skin presents certain appendages as hair, hoof and horn.

Hair

- The hairs are extremely variable in colour and size in different breeds and individuals.
- They cover the entire surface of the body and are of two kinds ordinary and special.
- The ordinary hair determines the colour of the coat of the animal.
- The special hairs are either tactile hairs on the lips, nostrils, eyelashes, tragi of external ear, vibrissae of the nostrils or the long hairs an the tail forming the brush.

Horns

- They are conical sheaths, which enclose the horn core of the frontal bones.
- They vary greatly in size, form and curvatures.
- The horn develops from the secreting membrane, the corium, which is kept attached to the horn core and is traversed by numerous blood vessels and nerves.
- The corium of the horn is similar to that of the foot.

- In the sheep, cutaneous pouches are present in certain situation called as the infraorbital or lacrimal pouch and interdigital pouch.
- The skin presents fine hairs and numerous sebaceous glands.

Hoof

- There are four hoofs in each limb in the ox. View animation...
- The accessory digits bear short conical horny coverings, the structure being the same as the hoof.
- The hoof has three surfaces an outer convex face, an interdigital face and a solar face.
- The hoof has only three parts periople, wall and sole. The frog, lateral cartilages and plantar cushion are absent.
- The cloven foot takes up the function of diffusing concussion.

SKIN APPENDAGES - SPECIES DIFFERENCES

Horse

- The **skin** is thinner than the ox. Sweat glands are well developed. The dorsal border of wither, neck and forehead presents long hairs. This is the **mane** of the horse. The tail bears long hairs, typical to the species.
- The **hoof** is a horny box, which encloses a number of sensitive cartilaginous and bony structures, etc., It consists of three parts *wall, sole* and *frog*.
- The **wall** is that part of the hoof, which is visible when the foot is on the ground. It covers the front and sides and is reflected inwards at its posterior aspect to form the **bars**. The**bars** appear on the ground surface as convergent bands, which subside in front and fused to the sole. They are united with each other by the frog. The anterior part of the wall is termed the **toe**, the sides as the **quarters** and the posterior part, the **heel**.
- It presents for description two surfaces and two borders. The **external surface** is convex from side to side and slopes from edge to edge. This slope is variable. It is more in the hind limb than in the forelimb. It is steeper at the sides than in front and more on the inside than outside. This surface presents **striae** from edge to edge indicating the direction of horn tubules of which it is composed. The **internal surface** is concave and bears about 600 horny laminae extending between the borders. Each bears a number of secondary laminae and these dovetail with those of the sensory laminae. The **upper** or **coronary border** is covered by layer of soft light coloured band, **periople**, which appears as a ring like prominence at the junction of skin and hoof. It is narrower in front but widens out laterally and completely caps the heels and blends below with the frog. The internal aspect of this border shows two grooves, an upper one for the perioplic band and a lower one for the coronary band, designated respectively as the **perioplic** and**coronary grooves**. The **perioplic groove** is narrow at the toe but becomes very wide at the heels. Conversely the **coronary groove** is wide in front and becomes narrow behind and blends with the perioplic groove. The grooves are perforated by small openings for the lodgment of the papillae of the sensory structures of the periople and coronary band. The **basal** or **ground border** is convex. It is thicker in front and thinner at the sides. Its inner face is united to the periphery of the sole by horn of lighter colour, which appears on the ground surface of the hoof as the **white line**.
- The **sole** constitutes the greater part of the ground surface of the hoof. It is crescentric in outline and presents two surfaces and two borders. The **internal surface** is convex and presents numerous fine openings as in the coronary groove. The **external** or **ground surface** is concave. The **anterior border** is convex and is joined to the wall. The**posterior border** is deeply notched and the bars and the apex of the frog are situated in these angles. The part between the bars and wall is the **angle of the sole**.
- The **frog** is a wedge shaped mass, which occupies the angle between the bars. It presents *four surfaces, a base* and an *apex*. The **internal surface** presents a central ridge the**frog stay**, which is high behind and subsides in front. On either side of this is a deep depression. This surface presents **fine striae** or openings for the corium. The **ground surface** presents a central sulcus bordered by two ridges the crura. The internal and external surfaces are united at the upper part with the bars and sole but are free below and form the **collateral sulci** bordered outwardly by the bars.

The **base** is depressed centrally and prominent at the sides where it unites with the angles of the wall. The **apex**occupies the central angle of the concave border of the sole and is blunt.

- Structure
  - The hoof is made up of epithelial cells, which are more or less keratinized except at the deepest part, stratum germinativum. Here, the cells are not keratinized but by their division maintain growth of the hoof. The cells are in part arranged to form horn tubes united by intertubular horn. The wall consists of three layers: (1) an **external layer of periople** (above) and stratum tectorium. The periople is made of soft nonpigmented tubular horn, which becomes white when the foot is soaked in water. It is continuous with the epidermis of the skin above. The **stratum tectorium** is a thin layer of horny scales which gives the outer face of the wall below the periople a smooth glossy appearance. (2) The **middle layer** which forms the bulk of the wall consists of horn tubes which run between the borders and (3) The **deep layer** of horny laminae composed of non-tubular horn.
  - The sole is made up of tubular and non-tubular horn
  - The frog is composed of softer horn, which is not fully keratinized.
  - The hoof is a vascular and receives its nutrition from the corium. It has no nerves

- Corium
  - The corium is the specially and highly modified part of the dermis of the skin and it furnishes nutrition to the hoof. It is composed of the following parts:
    - The **perioplic corium** is situated in the perioplic groove. It is continuous with the dermis above and is marked off from the coronary corium below and blends with it laterally. It completely blends with the corium of the frog and bears fine papillae which are received into depreciations in the horny part and it supplies nutrition to the periople.
    - The **coronary corium** occupies the coronary groove and furnishes nutrition to the bulk of the wall -middle layer. It has numerous fine papillae. It is wide in front but becomes very narrow posteriorly. It is attached by its deep face to the extensor tendons and cartilages of third phalanx.
    - The **laminar corium** bears primary and secondary laminae, which are interlaced with the corresponding horny laminae. It is attached to the laminar face of the os pedis by modified periosteum and supplies nutrition to the horny laminae.
    - The **corium of sole** nourishes the horny sole. It bears papillae and is continuous with the corium of bars and frog. The deep face is attached to the solar face of the os pedis.
    - The **corium of the frog** is moulded on the deep face of the frog. Its deep face is blended with the plantar cushion and it nourishes the horny frog.
    - The **plantar cushion** is a wedge shaped mass, which lies over the frog. It presents *four faces, a base* and *apex*. The **deep face** is connected to the fibrous sheath of the deep flexor tendon. The **superficial face** is covered by the corium of the frog. The **lateral faces** are related to the lateral cartilages of the third phalanx. The **base** is posterior, subcutaneous and is divided by a central depression into two rounded prominences bulbs of the cushion. The **apex** is adherent to the terminal part of deep flexor tendon. The blood supply is very poor. It consists of a meshwork of white and elastic fibres containing fat.
  - The **lateral cartilages** are attached to the angles of the third phalanx. The external face is convex and the internal face is concave. The upper border extends higher up and hence easily palpable. The lower border is thicker and is partly attached to the angle. The posterior end curves towards its fellow.
  - **Tendons:** The tendon of extensor pedis with the reinforcing branches of the suspensory ligament runs down over the joint and is inserted to the pyramidal process of the os pedis. The deep flexor tendon is behind.
  - **Bones:** The lower end of the second phalanx, the distal sesamoid or navicular bone and third phalanx.
  - The **ergot** is a small piece of horn situated in the tuft of hair at the flexor face of the fetlock vestige of the second and fourth digits.
  - The **chestnut** is a mass of horn on the medial face of the forearm about a handbreadth above the carpus and on the distal part of the medial face of the tarsus, vestige of the first digit.

Dog

- The **skin** is loose with variable thickness. The palmar surfaces of the carpus, metacarpus and digits are hairless and bear pads The **pad** is composed of fibro elastic tissue, fat and a thick keratinised epidermal covering. The size of the hairs is highly variable from breed to breed. The **claws** are five in a limb, one on each digit. The horn of each claw covers the concerned third phalanx and presents a body and sole. They curved downward.

Pig

- The **skin** of the pig is thick due to accumulation of subcutaneous fat. The **hairs** on the skin are sparse. The **hoof** resembles that of the ox. The hooves of the accessory digits are well developed.

Rabbit

- The **skin** is very soft due to the presence of moderate amount of subcutis fat. The **hairs** are long and cover most of the skin except muzzle. The tail is covered by thick short hairs. Palmar surface of foot bears **pads**. The claws are elongated and curved down wards. The tips are blunt .The **claws** are five in number one for each digit.

Fowl

- The skin appendages of the epidermis in fowl are *comb, wattles, earlobes, feathers, scales and claws*. **Beaks** are the horny covering of the upper jaws. The distal end of the metatarsus presents the metatarsal spur. It is capped by the horny covering.