MODULE-1: INTRODUCTION TO SPLANCHNOLOGY

What is Splanchnology?

- Splanchnology is the branch of science which deals with the study of visceral organs
- The visceral organs of the body include the organs of digestive, respiratory, urinary and genital organs
- Different organs together to perform a specific function in the body forms an Organ System

Organ systems

- Typically, each system has several organs designed to perform a specific set of functions. Organs are formed when different kinds of tissues group together
- These organs are then organized into systems that carry out major functions in the body
- Each system is then designed to work in unison with all other body systems. When one system malfunctions, the other systems are also affected
- The following systems constitutes splanchnology,

Digestive system

- The Digestive system is concerned with the nutrition of the animal
- The function of this system includes the prehension of food, its mastication, digestion (mechanical and chemical) and absorption of the nutrients
- The digestive organs are also concerned with the excretion of unabsorbed portion of the food
- The organs of the digestive system are traditionally divided in to two main groups
- First is the Gastrointestinal (GI) or alimentary canal, which is a musculo-membranous tube consisting of mouth, pharynx, oesophagus, stomach, small intestine and large intestine
- The second group includes the accessory structures of the digestive system such as the teeth, tongue, salivary glands, liver, gall bladder and pancreas

Respiratory system

- The Respiratory system consists of organs that exchange gases between atmosphere and blood
- The Respiratory organs are concerned with a continuous supply of oxygen to the living tissues and elimination of carbon dioxide from the body
- It also concerned with the production of voice. The organ of the respiratory system includes nose, nasal cavity, pharynx, larynx, trachea, bronchi and lungs

Urinary system

- The primary function of the Urinary organs is to keep the body homeostasis by controlling the composition and volume of blood
- This is done primarily by the kidneys which regulate the composition and volume of blood and remove waste from the blood in the form of urine
- The organs of this system consisted of two kidneys, two ureters, urinary bladder and urethra

Genital system

- The Genital organs are concerned with reproduction by which the thread of life is sustained
- The organs of male and female reproductive system may be grouped by function. Apart form the production of male and female gametes the reproductive organs are also involved in secretion of hormones that regulates the sexual activity
- The above four major organ systems are closely related functionally to the Cardiovascular and Lymphatic systems, to the Nervous system which controls their functioning, and to the Endocrine System
- The coordinated action of all these body systems helps in maintaining the homeostasis of the animal

- Most of the visceral organs of the body systems are lodged within the three major body cavities namely thoracic, abdominal and pelvic cavities. However, some of the organs are embedded in the tissues of the head, neck, and in the caudal part of the pelvis
- All the visceral organs inside the body cavities are lined by the serous membranes lining the body cavities

MODULE-2: BODY CAVITIES

Learning objectives

- To know the body cavities and its boundaries
- To know contents of the body cavities
- To know about the peritoneum and pleura

THORACIC CAVITY - OX

- The thoracic cavity is the second in size of the three body cavities. In form, it is somewhat like a truncated cone with the base cut off very obliquely and directed backwards
- It presents a roof, floor, two lateral walls, a caudal wall and an cranial aperture or inlet
- The bodies of the thoracic vertebrae form the roof. The lateral walls are formed by the ribs and intercostal muscles. The sternum forms the floor
- The caudal wall is formed by the convex face of the diaphragm
- The inlet is small, narrow and oval. It is bounded above by first dorsal vertebra below by the first segment of the sternum and laterally by the two first ribs
- It is closed in life by structures passing into and out of the thorax viz., the longus colli muscles, the trachea, the oesophagus, vessels, nerves and lymph glands
- A longitudinal septum termed the mediastinum thoracis or septum mediastinale, extends from the dorsal wall to the ventral and caudal walls, and divides the cavity into two lateral chambers termed the pleural cavity. Each of these chambers is lined by the serous membrane, called the pleura
- The mediastinum is, for the most part, not median is position, as might be inferred from its name this is correlated with the fact that the largest organ contained in it the heart, is placed more on the left side than on the right consequently the right pleural cavity and lungs are larger than the left
- Practically all the thoracic organs are in the mediastinal space between the pleurae, with the exception of the lungs, caudal vena cava and part of the right phrenic nerve
- The part in which the heart and the pericardium are situated together with that dorsal portion is usually called the middle mediastinal space; the parts before and behind this are termed respectively the cranial and caudal mediastinal spaces

SPECIES DIFFERENCES

Sheep and Goat

- It resembles that of ox
- The pleural sacs form a cul-de-sac on each side of the first lumbar vertebra
- Perforations are present in the cranial mediastinum of the sheep and it is not perforated in goat

Horse

- The thoracic cavity is larger
- The pleura are thin and the caudal mediastinum appears fenestrated and when these apertures are present the two-pleural sacs communicate with each other
- The apertures do not exist in the fetus

Pig

- The thorax is rounded due to strongly curved ribs
- The pleural sacs extend forward to the first intercostals space
- The diaphragmatic line of pleural reflection begins at or a little above the sternal end of the seventh and extends in a gentle curve to about the middle of the last rib
- When a fifteenth rib present, it does not affect the arrangement of the pleura of the diaphragm

Dog

- Thorax is proportionately larger
- Mediastinum is imperforate, but permeable to gas and water
- Both right and left cupola pleurae extend beyond the cranial border of the first rib

Rabbit

- General plan resembles the ox

Fowl

- Since the *diaphragm is absent*, there is no separate thoracic cavity

PLEURAE

- The pleurae are serous membranes, which enclose on each side a pleural cavity. These line the walls of the thorax from the lateral laminae of the mediastinum, and then reflected from the latter upon the surface of the lungs. Thus we distinguish parietal, mediastinal and pulmonary or visceral parts of pleura
- The parietal pleura line the thoracic walls. On the lateral thoracic wall it is adherent to ribs and intercostal muscles and is termed the costal pleura
- Behind it is closely attached to diaphragm, forming the diaphragmatic pleura
- The mediastinal pleura cover the organs in the mediastinal space and are in part in opposition with the opposite sac
- The part which is adherent to the pericardium is the pericardiac pleura. From the mediastinum, each pleura is reflected on the corresponding lung forming the pleura pulmonalis or the visceral pleura. The reflection occurs around and behind the hilus of the lung
- Caudal to the root of the each lung, there is a horizontal fold of pleura called the pulmonary segment
- The right pleura forms a special sagittal fold, which encloses the caudal vena cava in its upper edge; it is therefore called the fold of the vena cava (Plica venacava)
- It gives off a small accessory fold for the right phrenic nerve
- The pleural cavity contains a film of clear serous fluid, the liquor pleurae
- The cavity is normally a capillary space
- The pleura resemble the peritoneum in structure and appearance
- It is attached to the structures that it covers by a subserous tissue called endothoracic fascia
- The cupola pleurae or apex of each pleural sac lies at the thoracic inlet
- The right cupola projects beyond the cranial border of the first rib under the scalenus. The left cupola usually does not extend beyond the plane of first rib

ABDOMINAL CAVITY
(Ox, Sheep & Goat, Horse)

Ox

- The abdominal cavity is the largest of the body cavities
- It is separated from the thoracic cavity by the diaphragm and continuous behind with the pelvic cavity; the line of demarcation being the terminal line or pelvic inlet

- The cavity is ovoid in form and is compressed laterally
- Its long axis extends obliquely from the centre of pelvic inlet to the sternal part of diaphragm
- Its greatest dorso ventral diameter is at the level of the first lumbar and the greatest transverse diameter near the pelvis.
- It presents a roof, floor, two lateral walls and cranial wall.
- The lumbar vertebrae, lumbar part of diaphragm and sub-lumbar muscles forms the roof
- The oblique and transverse abdominal muscles, tunica abdominalis, part of ilia, iliacus muscles, cartilages of asternal ribs and parts of caudal ribs below the line of attachment of diaphragm form the lateral walls
- The two recti abdominis, aponeuroses of oblique and transverse abdominis muscles, tunica abdominalis and xiphoid cartilage form the floor
- The diaphragm forms the cranial wall

Note

The costal attachment of diaphragm is almost vertical from the ventral end of the 8th rib to the dorsal end of the 13th rib (and the last 4 ribs enter more largely into the formation of the abdomen than in horse).The flank is more extensive than in horse.The transverse diameter between the last ribs is greater than in horse.The abdomen in the ox is more capacious than that of the horse

- A layer of fascia lines the muscular walls and the subserous tissue unites the fascia and the peritoneum, the latter is loaded with fat except over diaphragm and sends laminae into various peritoneal folds. The abdomen is lined by the serous membrane-the peritoneum
- The walls of abdominal cavity are pierced by five openings, three of the diaphragm and two of the inguinal canals. In the fetus, there are in addition, the umbilical openings
    - Foramen vena cava-for the passage of caudal venacava
    - Hiatus oesophagi-for the passage of esophagus and dorsal and ventral branches of vagus nerve
    - Hiatus aorticus-for the passage of abdominal aorta
    - Femoral ring-it is placed on either side of the pelvic brim and transmits femoral vessels
    - Inguinal ring-for the passage of spermatic cord in males and external pudic vessels and nerves in the female
    - Umbilical opening-it is placed only in the fetus for the passage of two umbilical arteries, two umbilical veins and urachus

Contents

- Greater part of digestive and urinary organs, part of the internal genital organs, blood vessels, nerves, lymphatic glands, ductless glands and certain fetal remnants
- For description of the location of these organs, the abdominal cavity is divided into 9 regions by four imaginary planes

- Two of these are sagittal and two are in transverse plane. Of the two, one transverse plane pass through the last thoracic vertebra and the other through the 5th lumbar vertebrae
- The transverse planes divide the abdomen into three zones, one behind the other - Epigastric, Mesogastric and Hypogastric
- These are again subdivided in to nine regions by sagittal planes, which pass through the centre of the inguinal ligament

Left parachondriac	Xiphoid	Right parachondriac
Left lumbar	Umbilical	Right lumbar
Left iliac	Prepubic	Right iliac

- Other regional terms used for descriptive purposes are sublumbar, diaphragmatic and inguinal
- The inguinal regions lie in front of the inguinal ligament. Flank is that part of lateral wall which is formed only of soft structures
- The triangular depression in the upper part of the flank (bounded dorsally by the lateral border of the longissmus, ventrally by the upper border of obliquus abdominis internus and in front by the last rib) is termed the paralumbar fossa

TOP

Sheep and Goat

- It is as in ox

TOP

Horse

- Abdomen is less capacious due to
    - the lumbar transverse process being one fourth shorter than in ox (flank less extensive)
    - the transverse diameter between the last ribs being lesser than in ox
    - the costal attachment of the diaphragm being a gentle curve and not steep as in ox
- Flanks are not hollow and the floor of the abdomen is more tucked up

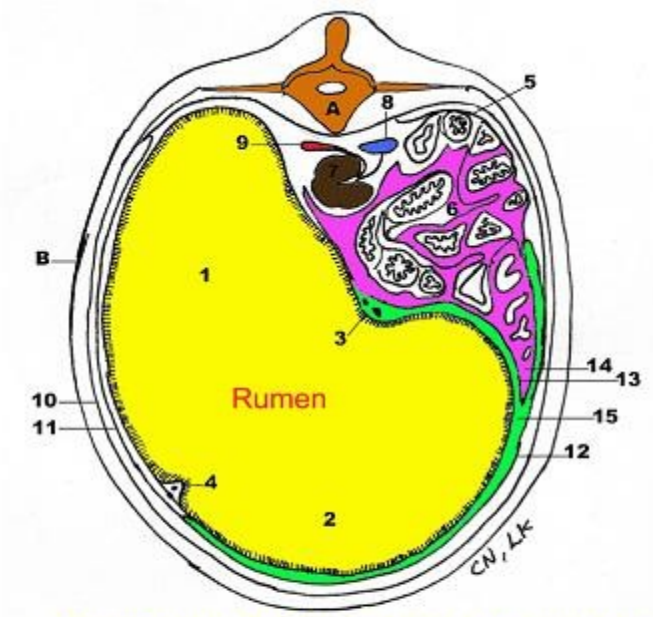
PERITONEUM

- Peritoneum is the serous membrane which lines the abdominal cavity and a part of pelvic cavity and the organs contained in them
- In the male, it is completely closed one. In the female there are two small openings in it, and these are abdominal openings of the oviducts
- The peritoneum, which covers the parieties, is called parietal peritoneum, which is reflected over the contained organs, the visceral layer of peritoneum
- The peritoneal cavity is a potential space formed between two layers, parietal and visceral, which are normally in contact with each other
- It contains a thin film of serous fluid that acts as a lubricant. Though the peritoneal cavity as a whole is single, it is divisible in to two sacs
- The greater sac is exposed when the inferior wall of the abdomen is cut through
- The lesser sac forms only diverticulum of the greater sac, which envelops the intestines
- The two sacs are continuous with each other through the foramen of Winslow or epiploic foramen
- The peritoneum gets reflected on the organs contained in the cavity to form their outermost covering
- It then extends into a number of folds, which extend between the various organs or connect them to the walls
- These folds serve to hold the organ in position and also to enclose the vessels and nerves passing through them. They are as follows,
    - A double fold passing from the stomach to the other viscera is an omentum E.g.. greater omentum
    - A double fold that attaches the intestine to the dorsal abdominal wall is mesentery E.g.. common mesentery of ox and dog
    - A double fold, which attaches viscera other than parts of the digestive tube to the walls, is ligament, E.g.., ligament of liver
    - Omentum and mesentery transmit blood vessels and nerves to the organ whereas a ligament does not, except the broad ligament of the uterus

OMENTUM

Ox

- These are two in number -the greater and the lesser
- The greater omentum conceals the greater part of the intestine on the right side except duodenum and covers the ventral sac of the rumen almost entirely



Cross section of the abdomen of Ox at the level of 4 th LV
A – 4 th lumbar vertebra B – Abdominal wall
1. Dorsal sac 2. Ventral sac of rumen 3. Right longitudinal groove
4. Left longitudinal groove 5. Ascending duodenum 6. Coils of intestine
7. Right kidney 8. Posterior vena cava 9. Aorta
10. Parietal peritoneum 11. Visceral peritoneum 12. Superficial wall
13. Deep wall of greater omentum 14. Supraomental recess 15. Omental bursa

- It is composed of two layers,
    - The *superficial layer* extends from the left longitudinal groove of the rumen, curves ventrally around the ventral sac of the rumen, and ascends to the right side covering the deep layer of the omentum. It ends along the second part of the duodenum and the greater curvature of the abomasum
    - The *deep layer* is attached along the visceral surface of the rumen ventral to the right longitudinal groove of the rumen and curves around the intestinal mass on the right side and is covered by the superficial part. It ends chiefly by blending with the medial layer of meso-duodenum but cranially it is attached on the first bend of the colon and the visceral surface of the liver along the ventral border of the pancreas.The two parts are continuous at the attachment along the caudal transverse groove of the rumen
- The superficial and deep layers thus enclose a potential space, the omental bursa. The greater omentum stores considerable amount of fat
- The lesser omentum is a double fold extending from the liver (oesophageal notch to portal fissure) to the parietal surface of the omasum, pyloric part of the abomasum and the first part of duodenum

PERITONEUM AS A WHOLE

Ox

- Tracing the peritoneum as a whole, we may consider it as consisting of two sacs a greater and a lesser
- The greater sac lines the greater part of the abdominal cavity and covers most of the viscera, which have a peritoneal investment
- The lesser sac formed by the two layers of greater omentum, is an introversion or invagination of the greater sac, formed during the development of the viscera
- The cavity of the greater sac is termed general peritoneal cavity
- The cavity of the lesser sac is the omental cavity - a potential space, similar to the general peritoneal cavity
- The two cavities communicate by a relatively narrow passage termed the epiploic foramen (foramen of Winslow). This opening is situated on the visceral face of liver

- It is almost sagittal in direction, formed between caudate lobe of liver dorsally and portal vein and pancreas ventrally
- Its walls are normally in contact and the passage merely a potential one.
- We may now trace the peritoneum in a longitudinal direction beginning in front
- It is reflected from the ventral abdominal wall and the diaphragm upon the liver forming the ligaments of the liver and its serous coat
- It leaves the liver as lesser omentum and becomes continuous with the mesoduodenum and greater omentum
- From the dorsal abdominal wall it is reflected on the rumen and spleen to form their serous coat and greater omentum on the left
- The reflection from the dorsal abdominal wall in the midline forms the common terminal part of the colon in the sublumbar region and the rectum in the pelvic cavity forming the mesocolon and mesorectum respectively
- It is then reflected from the rectum to the dorsal surface of the bladder to form the genital fold (broad ligaments in the female) and passes to the body wall laterally and ventrally to form the lateral and middle ligaments of the bladder. In the newborn, the following folds are very large
- The falciform ligament of liver extends to the umbilicus, and contains in its free edge the large umbilical vein
- The bladder at this time an abdominal organ has a ventral median fold, which connects it and the umbilicus and contains the large umbilical artery

PELVIC CAVITY
(Ox, Sheep, Goat, Horse)

Ox

- The pelvis is the smallest of the three body cavities
- It is continuous in front with the abdominal cavity, the line of demarcation being the terminal line or the pelvic inlet
- The sacrum and the first 3 coccygeal vertebrae form the roof. The pubis and ischium furnish the floor
- The lateral walls are formed by parts of the ilium and the sacro-sciatic ligaments
- The outlet is bounded above by the 3rd coccygeal below by the ischial arch and laterally by the caudal border of the sacrosciatic ligaments. Perineal fascia, anus, its muscles, roots of penis in the male and vulva in the female close the outlet
- This cavity contains rectum, parts of internal genital and urinary organs, vessels and nerves, muscles and some fetal remnants
- The pelvic peritoneum is continuous with that of the abdomen
- It lines the cavity for a variable distance backward and is then reflected on the viscera and from one organ to another
- Thus there is an cranial peritoneal and a caudal retroperitoneal part of the cavity
- In the male the peritoneum is arranged as follows,
    - The peritoneum is reflected from the sacrum to the rectum, forming mesorectum. Between the sacrum and rectum there is a pouch called sacro rectal pouch, which is continuous laterally with the rectogenital pouch
    - In male, a transverse fold of peritoneum extends between the inferior face of the rectum and the dorsal surface of the bladder. This is the genital fold, which contains the vas deferens and seminal vesicles
    - The ventral layer of this fold is reflected on to the dorsal surface of the bladder. Thus there is a pouch formed between the rectum and the bladder
    - Thus a pouch is formed between the rectum and the bladder the recto vesical pouch that is partially subdivided by the genital fold into recto-genital and vesico-genital cavities
    - From the bladder, the peritoneum is reflected to the lateral walls of pelvic cavity, forming the lateral umbilical fold or middle ventral ligament of the bladder
    - The lateral ligaments contain the so-called round ligament of the bladder, the partially occluded umbilical artery, of the fetus
    - In the female, by the presence of uterus, the genital fold is enlarged to enclose the uterus and a small part of the vagina
    - It forms two extensive folds the broad ligaments of the uterus, which attach the organ to .the sides of pelvic cavity and upper part of the flanks below the level of tuber coxae
    - It thus divides the recto-vesical pouch completely into dorsal and ventral compartments -the recto-genital and vesico-genital pouches

- In the fetus and the newborn these three folds extend to the umbilicus in conformity with the abdominal position of the bladder
- When the bladder becomes pelvic in position, the lateral ligaments conform to the change and end at the vertex of bladder. The median fold may still be traceable to the umbilicus

TOP

Sheep and Goat

- As in ox

Horse

- Pelvic cavity is relatively short and broad
- The inlet is less oblique and its transverse diameter is greater than in ox
- The peritoneum extends as far back as caudal end of sacrum only and so the retro peritoneal part is more than in ox

MODULE-3: DIGESTIVE SYSTEM - PART I

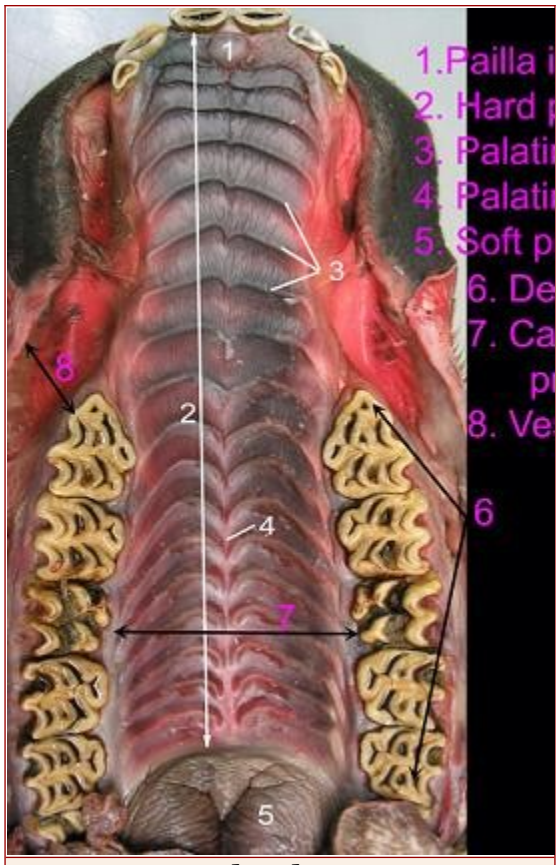
Learning objectives

- To know about the most troublesome system i.e digestive system
- To know about the non mechanical grinder of animals
- Mouth and its contents in part by part

MOUTH
(Ox, Sheep & Goat, Horse,Pig, Dog, Rabbit, Fowl)

Ox

- The mouth or cavum oris is the first section of the alimentary canal
- It is a short but wide cylindrical cavity and when closed, is completely filled up by the contained structures except for a small space, which remains between the root of the tongue, soft palate and the epiglottis - the glosso-epiglottic space
- It is bounded superiorly by the hard palate, inferiorly by the body of the mandible and mylohyoideus muscles, laterally by the cheeks, posteriorly by the soft palate
- The anterior opening of the mouth, the rima oris is closed by the lips
- The posterior opening of this cavity communicates with the pharynx -the isthmus faucium
- The oral cavity is subdivided into two parts by the teeth and alveolar processes (dental arch)
- The external part between the teeth and cheeks is the vestibule, which becomes evident when food accumulates in this space
- The space enclosed within the teeth and alveolar processes is the mouth cavity proper or cavum oris proprium



Palate horse

- The mouth cavity is lined by mucous membrane, which is pink in colour and more or less pigmented
- It is continuous with the skin at the margin of the lips and behind it is continuous with the lining of the pharynx

TOP

Species difference

Sheep and Goat

- It resembles ox

Horse

- The cavum oris is longer and narrower
- The vestibule is less capacious and the mucous membrane may be pigmented (lips and cheeks)

Pig

- The rima oris is extensive and the angle of mouth is situated far back

Dog

- The form and size vary greatly in different breeds, being long and narrow in some, short and wide in others
- Rima oris is extensive

- Mucous membrane may be pigmented (lips and cheeks)

TOP

Rabbit

- The cavum oris is elongated

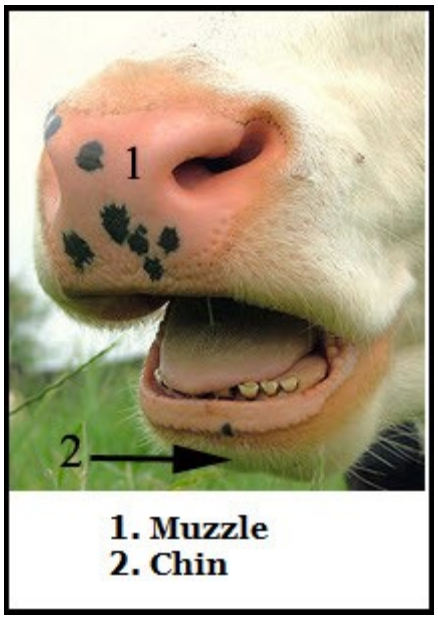
Fowl

- The cavum oris is triangular in outline.
- Vestibule is absent, as there is no teeth

LIPS (LABIA ORIS)

Ox

- The lips are two-upper and lower and are thick, wide and comparatively immobile musculo- membranous folds, which surround the rima oris
- The angles of union of the lips- the commissures are situated 5cm behind the level of the corner incisor tooth. Each lip presents two surfaces and two borders
- The middle part of the external surface of the upper lip and the surface between the nostrils is bare and is termed the muzzle



- It is kept cool and moist by a fluid secreted by the nasolabial glands resent under the skin
- The muzzle is smooth and shows irregular lines mapping out small polygonal areas on which the duct of the naso-labial glands open
- The rest of the surface presents long tactile hairs in addition to the ordinary fine hairs.
- The external surface of the lower lip has rounded prominence, the chin and it presents the short and long hairs
- The internal surface is covered with mucous membrane. Small folds of mucous membrane the frenula labii pass from the lips to the gums
- The attached border of each lip is continuous with the surrounding structures
- The free border of each lip is bare and presents on its free edge a number of short and blunt horny papillae

- They become larger, longer and pointed towards the angles

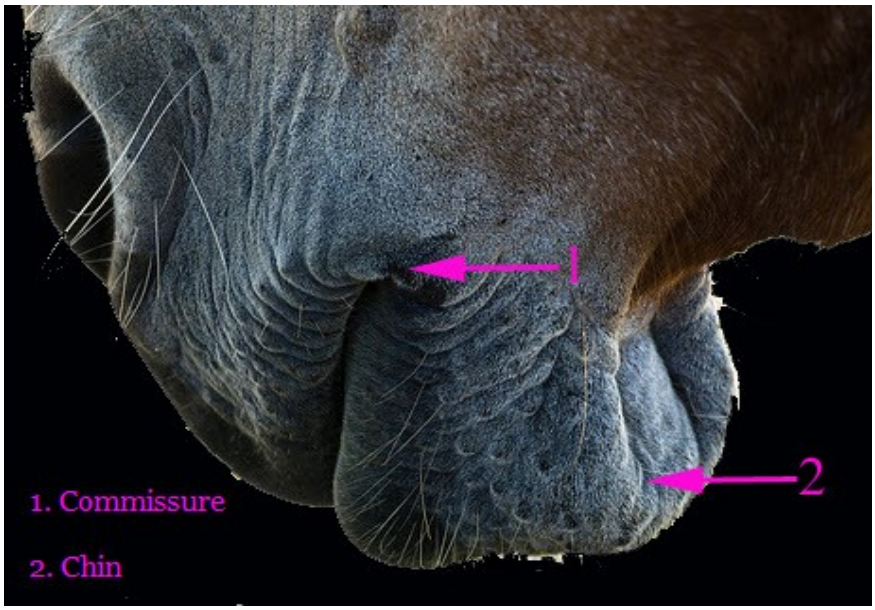
Species difference

Sheep and Goat

- The lips are mobile and thin and are the organ of prehension
- The upper one is marked by a very distinct philtrum and otherwise is not bare

Horse

- The lips are thinner, narrower and more mobile. The lips are the organs of prehension
- The upper lip on its external surface has a shallow median furrow the philtrum
- Mucous membrane may be pigmented
- Horny papillae are absent
- The angle of union of lips is about the level of the first cheek tooth

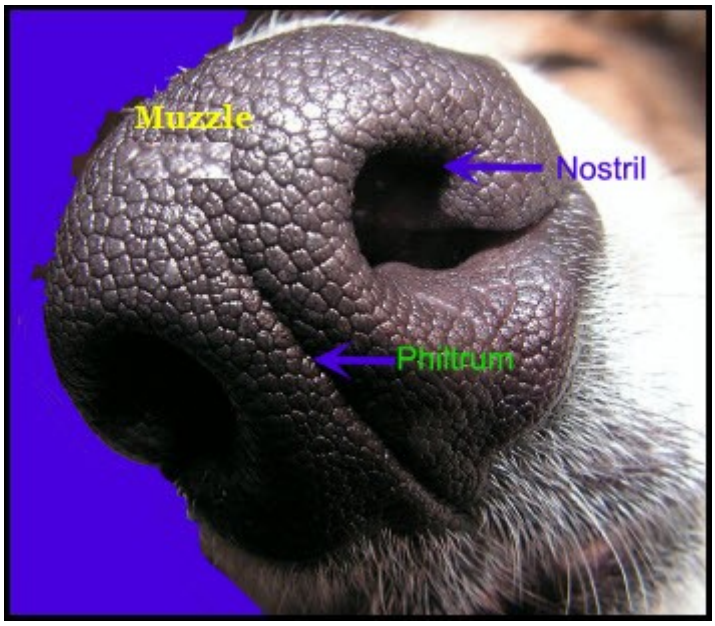


Pig

- The upper lip is thick and short and is blended with snout.
- The lower lip is small and pointed. The labial glands are few and small

Dog

- They are thin and mobile presenting numerous tactile hairs. The upper lip projects over the lower lip and covers it more or less at the sides
- The muzzle presents a deep groove or cleft, the philtrum giving the appearance of harelip
- The commissures are about the level of the third or the fourth cheek tooth
- Mucous membrane may be pigmented
- Horny papillae are absent



Rabbit

- The upper lip is fleshy and divided into two halves, which are placed on either side of the incisors below nasal flap
- Muzzle is absent
- Plenty of tactile hairs spring from the skin covering upper lip

Fowl

- The lips are absent

CHEEKS
(Ox, Sheep & Goat, Horse,Pig, Dog, Rabbit, Fowl)

Ox

- The cheeks form the lateral wall of the mouth cavity and are continuous with the lips in front
- They are attached to the alveolar borders of the maxilla and premaxilla above and mandible below
- The cheeks consist of from without inwards as,
    - Skin
    - Muscular and glandular layer
    - Mucous membrane
- The skin of the face continuous over the cheek without any modification
- The muscular layer chiefly made up of buccinator muscle. The buccal glands are well developed and arranged in three rows
- The *dorsal row* extends from the angle of the mouth to the maxillary tuberosity and is made up of light yellow lobules. The *ventral row* consists of compact brownish masses, which extend from the angle of the mouth a short distance under the masseter muscle
- The *middle row* consists of scattered yellow lobules situated on the deep face of the buccinator muscle
- The ducts of these glands open into the mouth between the papillae of the cheek
- The mucous membrane is reflected upon the gums and is continuous behind with that of the soft palate
- It presents large, pointed conical horny papillae, which are directed backwards towards the isthmus faucium and are covered with horny epithelium
- The largest of these measure about half an inch and are placed around the angle of the mouth

- A large papilla the *papilla salivalis* is seen about the level of the upper fifth cheek tooth and it shows on its summit the opening of the *Stenson's duct* (duct of the parotid salivary gland)

TOP

Species difference

Sheep and Goat

- Resemble ox

TOP

Horse

- Cheeks are less capacious.
- Buccal glands are arranged in two rows - a dorsal row on the outer face of the buccinator muscle near its upper border and a ventral row in the submucous tissue at the lower border of the buccinator muscle
- Papilla salivalis is about the upper third cheek tooth
- Mucous membrane may be pigmented
- Horny papillae are absent

TOP

Pig

- The mucous membrane of the cheeks is smooth
- The buccal glands are compactly arranged in two rows opposite to the cheek teeth
- The parotid duct opens opposite to the 4 or 5 th cheek tooth

TOP

Dog

- Loose and capacious
- Papilla salivalis is about the upper third cheek tooth
- Near the last cheek tooth are the openings of the ducts of the Zygomatic gland (homologous with dorsal buccal glands of other animals)
- Ventral buccal glands are opposite the level of the cheek teeth
- Mucous membrane may be pigmented and smooth
  Horny papillae are absent

TOP

Rabbit

- The cheek is covered with fine hairs

Fowl

- Cheeks are absent

GUMS

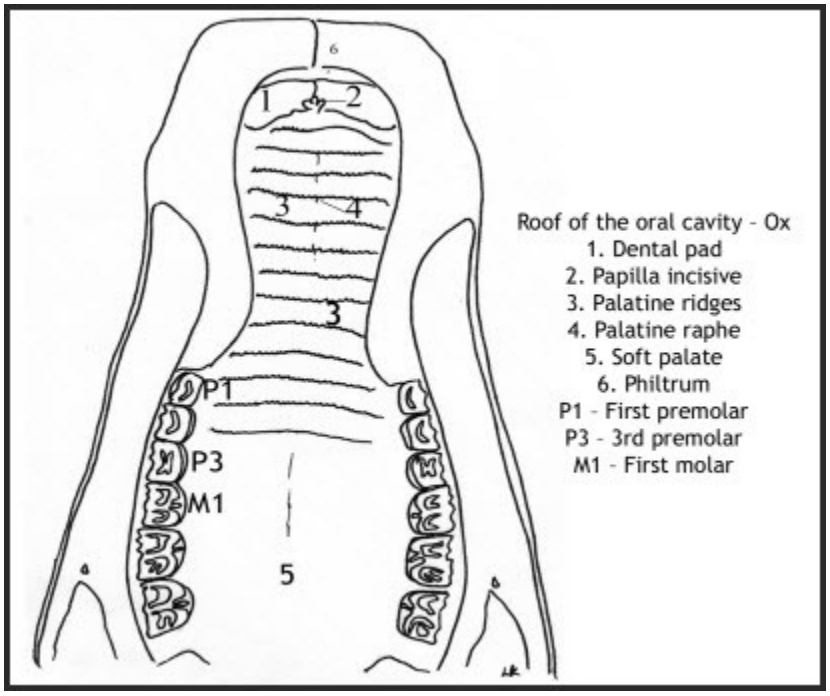
Ox

- The gums are composed of dense fibrous tissue intimately blended with the periosteum of the alveolar processes and surround the neck of the teeth
- They are reflected with alveoli and become continuous with the alveolar periosteum
- They are covered with mucous membrane destitute of glands and of a low degree of sensibility

HARD PALATE (PALATUM DURUM)
(Ox, Sheep & Goat, Horse,Pig, Dog, Rabbit, Fowl)

Ox

- The hard palate forms the roof of the cavum oris
- It is bounded in front by the dental pad on the sides by the alveolar arches and continuous behind with the soft palate
- It is attached above to the bony palate formed by the palatine processes of the premaxilla, maxilla and palatine bones
- The submucous tissue, which attaches it to the bony palate, contains a very rich venous plexus constituting erectile tissue
- A central *raphe* divides its oral surface into two halves each of which presents 15 to 19 ridges. These ridges are nearly straight and are serrated at their free borders
- The ridged condition is present only in the anterior two-thirds, the posterior third being smooth
- The mucous membrane is more or less pigmented.
- The body of premaxilla is covered with the thick layer of dense fibrous tissue, which is covered by horny epithelium called the *dental pad*. Between this, and the first ridge is a central prominence- the *papilla incisiva*
- It is margined on either side by a fissure, which presents the oral opening of the *ductus incisivus (naso-palatine duct)* whereas the nasal opening of which is on the floor of the nasal cavity



TOP

Species difference

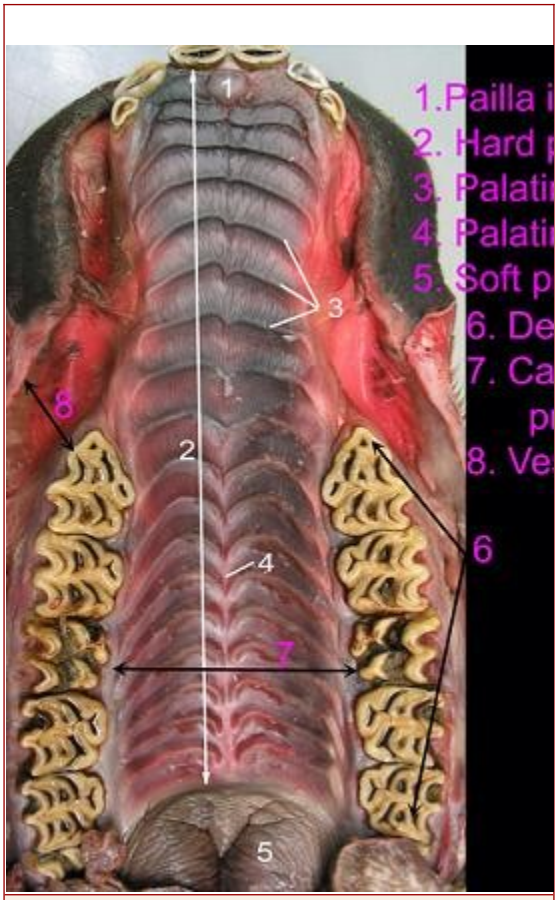
Sheep and Goat

- A median raphe palati is present
- The transverse ridges alternate with the opposite side, which are 14 in number
- Dental pad is present

TOP

Horse

- The ridges in each half are 18 in number and are curved with the concavity directed backwards
- The dental pad is absent and instead there are six alveoli for the upper incisors
- The oral surface is ridges throughout
- The fissures on the sides of the papilla incisiva do not contain the openings of the ductud incisivus, as they are blind
- The hard palate as a whole is large but narrower



Palate horse

TOP

Pig

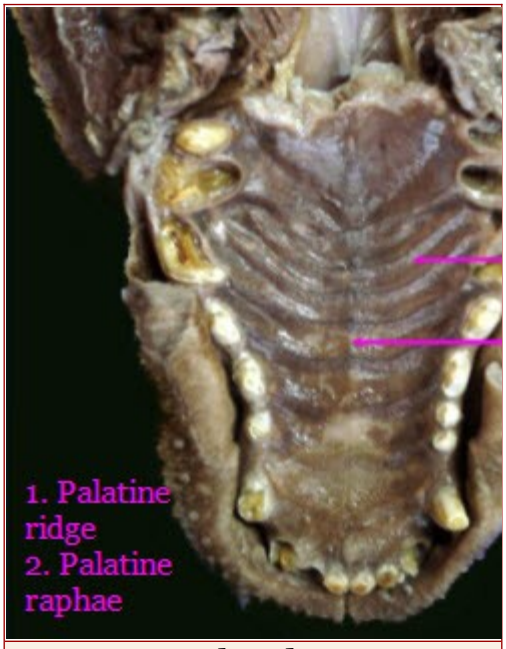
- It is long and narrow.
- A median furrow, on each side of which are marks it 20 or more ridges.

- On its anterior part there is a long narrow prominence, the papilla incisiva and the posterior part of which the ductus incisivus or naso-palatine ducts open. There is a round prominence in front of the first pair of the incisors

TOP

Dog

- It is widest between the fourth pair of cheek teeth
- It presents 8 to 10 curved ridges
- Behind the first pair of incisors is the triangular papilla incisiva, on the sides of which open the naso -palatine ducts
- Mucous membrane is pigmented



Palate dog

TOP

Rabbit

- It presents about 15 ridges
- The ridges at the posterior part are directed backward
- A faint median groove is present at the posterior part of the hard palate

TOP

Fowl

- It is narrow and triangular.
- Anteriorly there is a median ridge and posteriorly a median slit, which represents the single posterior nare for both the nasal cavities behind
- A lateral ridge extends from the median ridge posteriorly, the whole length of the palate
- Behind the median ridge are five transverse rows of horny pointed papillae directed backwards
- The most posterior one marks the limit of the mouth cavity
- On either side of the median ridge are the openings of the maxillary glands

- On either side of the lateral ridges are the openings of the medial and lateral palatine glands

SOFT PALATE (PALATUM MOLLE)
(Ox, Sheep & Goat, Horse,Pig, Dog, Rabbit, Fowl)

Ox

- The soft palate is a musculomembranous partition, which separates the mouth from that of the pharynx except during deglutition
- It slopes obliquely downward and backward from the hard palate. It presents two surfaces and two borders
- The *oral or cranial surface* faces downwards and forward and is covered with mucous membrane continuous with that of the hard palate
- Numerous fine ducts of the palatine glands open on this face
- This oral mucous membrane detaches on either side a short thick fold passes to the lateral border of the tongue and these are the *cranial pillars of the soft palate*
- The pharyngeal surface faces backward and upward and is covered with mucous membrane continuous with that of the pharynx
- The *free or inferior border* is concave, and this is in contact with the epiglottis except during deglutition
- This border is continued on each side by a fold of mucous membrane, which passes to the lower part of the lateral wall of the pharynx called the *caudal pillars of the soft palate*
- The space between the cranial and caudal pillars on either side is deeply concave -the *tonsillar sinus* containing a bean shaped *tonsil*
- The tonsil projects outwards and does not occupy the tonsillar sinus, so it is not actually visible in the mouth cavity, as in the dog or horse

TOP

Species difference

Sheep and Goat

- It resembles ox

TOP

Horse

- It is very long and well developed being about 6" in length. It closes the isthmus faucium along with the epiglottis and hence in equidae oral breathing is not possible and in vomiting, the ejected matter escapes through the nose
- There is no compact tonsil but a mass of lymphoid tissue
- The caudal pillars unite over the beginning of the oesophagus

TOP

Pig

- It is very thick. It is entirely horizontal
- It has a small median prolongation termed the uvula
- The oral surface presents a median furrow, on either side of which is an oval raised area marked by numerous crypts and the elevations are the tonsils

TOP

Dog

- It is thick
- The tonsillar sinus is large and tonsil is well developed. It is red, about an inch long and is concealed between two folds of mucous membrane
- The caudal pillar is double on either side; the upper fold passes to the dorsal wall of pharynx and lower fold to the side of the epiglottis

TOP

Rabbit

- The soft caudal portion of the mouth is not supported by the bone

TOP

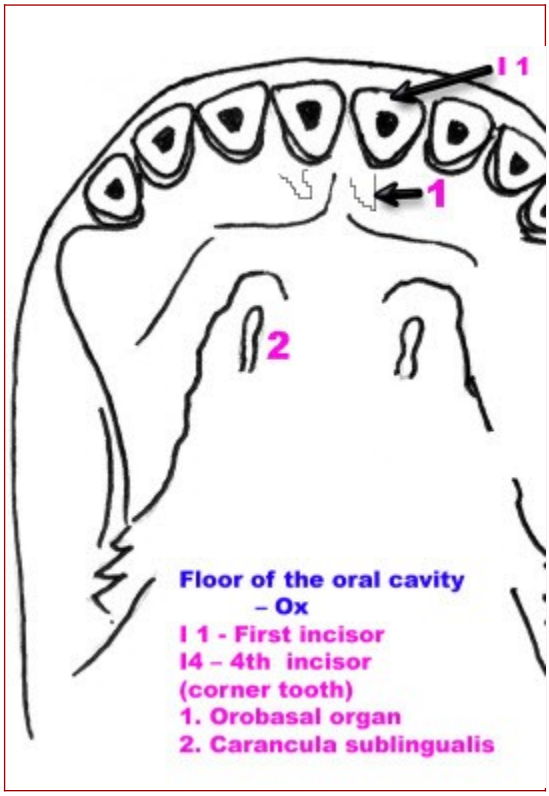
Fowl

- The soft palate is absent

FlOOR OF THE MOUTH
(Ox, Sheep & Goat, Horse, Pig, Dog, Rabbit)

Ox

- The floor of the mouth is free only in its cranial part and is formed by the body of the mandible covered by mucous membrane



Oral cavity - Ox

- The attached portion of the tongue occupies the reminder of the floor. By drawing the tongue aside, the following structures may be noticed
- About opposite to the corner tooth or slightly behind its level are papillae - *the caruncula sublingualis or barb* through which the ducts of the mandibular and ventral part of sublingual salivary glands open into the mouth
- The papilla is wide, hard and serrated. Just behind these papillae is a median fold of mucous membrane passing to ventral face of the tongue -the *fraenum linguae*
- A linear series of horny papillae are seen on the floor on either side of the fraenum linguae near which the ducts of the dorsal part of the sublingual salivary gland open
- Behind the last tooth a vertical fold of mucous membrane passes from the upper to the lower jaw, the *plica pterygomandibularis* that contains a ligament of the same name

TOP

Species difference

Sheep and goat

- It resembles ox

TOP

Horse

- The caruncula sublingualis is opposite the canine tooth and on it opens the mandibular duct
- From either side of the fraenum linguae and extending backward to the level of the lower 4th cheek tooth is a mucous fold - the sublingual fold, which covers the gland of the same name and presents numerous small papillae through which the ducts open
- The linear series of papillae on the floor is absent
- The isthmus faucium is relatively small and not dilatable

TOP

Pig

- The frenulum linguae are double
- There is a well–marked glosso-epiglottic fold, on either side of which is a depression

TOP

Dog

- Sublingual fold is present and it shows the openings of cranial part of the sublingual gland
- Caruncula sublingualis is indistinct

TOP

Rabbit

- The duct of the infra orbital gland runs forward into the floor of the buccal cavity

ISTHMUS FAUCIUM

Ox

- The isthmus faucium is the orifice of the communication between the mouth and pharynx
- It is bounded above by the soft palate, below by the root of the tongue and laterally by the cranial pillars of the soft palate
- It is circular, wide and very dilatable

MODULE-4: DIGESTIVE SYSTEM - PART II

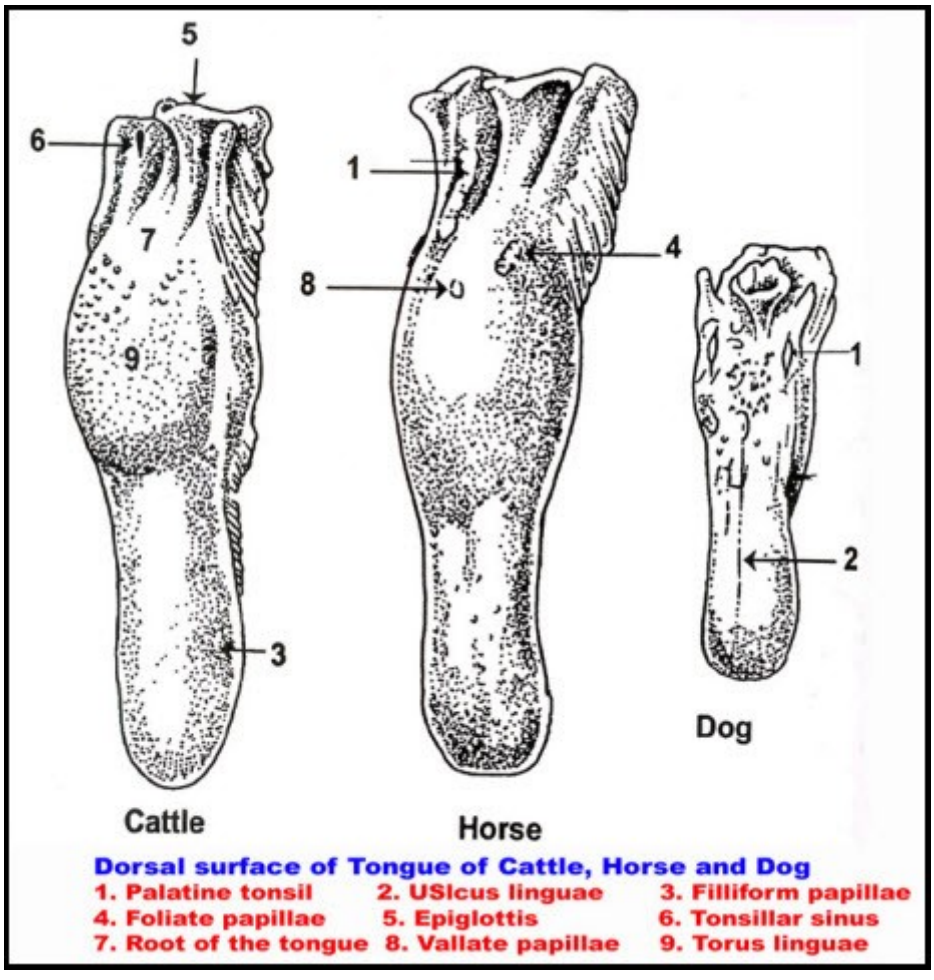
Learning objectives

- To know the organ of prehension and its supporters i.e teeth and salivary glands
- To know about the anatomical support in the digestive process

TONGUE (LINGUA)

Ox

- The tongue is situated on the floor of the mouth, between the rami of the mandible. It is highly protractile and is the chief organ of prehension. It consists of *a root, a body and the tip*.



- The *root* is the caudal part and it is attached to the hyoid bone, soft palate and pharynx. Only its upper surface is free and slopes downwards and backwards.
- The *body* has three free surfaces. The upper face is rounded and the lateral faces are flattened. The inferior face is related to the lingual muscles.
- *Tip of the tongue* is free and somewhat pointed. It presents upper and lower faces and a border.
- The *dorsum linguae* are the dorsal surface of the tongue. It is free throughout and is in contact with the palate except at the *glosso-epiglottic space*. The caudal part of the dorsum presents a remarkable eminence, the *torus linguae,* which is sharply defined in front by a transverse depression. (Click to see the image)

Structure

  - Mucous membrane
  - Muscles and glands
  - Vessels and nerves
- The mucous membrane is variably pigmented and is intimately adherent to the subjacent tissue except at the lower part of the lateral faces of the body and the ventral face of the tip
- On the dorsum it is very thick and dense and on the sides it is thin
- From the lower face of the free part of the tongue a fold of mucous membrane passes to the floor of the mouth - the *fraenum linguae*
- Behind, a fold passes from each side of the edge of the dorsum to the soft palate -the cranial pillar of the soft palate
- A thick central glosso-epiglottic fold passes from the root of the tongue to the base of the epiglottis and this fold contains the myo-epigloticus muscle
- The surface of the mucous membrane presents various kinds of papillae. In front of the prominence are large *horny papillae*, which are conical and *filiform*, which impart to the tip especially its rasp -like roughness
- The filiform papillae are fine, finger like projections on the dorsum and margin of the tip
- The fungiform papillae are large, button like scattered over the dorsum
- They are numerous on the lateral aspect of the tongue
- The free ends of these papillae are round and convex. Each papilla is supported by a neck and is attached to the mucous membrane by a short stalk
- The circumvallate papillae are arranged in 2 rows, are large and circular. They are 10-16 in number on each side
- They are sunk in deep depression bounded by annular wall
- The papillae on the prominence are large, broad and some of which are blunt and conical and others rounded and flattened and are termed lenticular papillae
- The fungiform and vallate papillae are furnished with taste buds
- Lymphoid tissue is present in the caudal part of the dorsum on each side of the glosso-epiglottic fold forming *lingual follicles*
- The lingual glands are present in the sub mucous tissue
- The lingual muscles are well developed

TONGUE (SHEEP AND GOAT)

- It resembles ox in form
- The tip is comparatively smooth
- The papillae are very numerous but short and blunt
- The prominence in the dorsum is commonly not so pronounced and sharply marked off in front as in the ox
- The root is smooth
- The mucous membrane is often pigmented in spots

TONGUE (HORSE)

- The body and root are narrower
- The tip is rounded and is spatula- like
- Prominence on the dorsum is absent

- The mucous membrane is not pigmented
- The *vallate papillae* are only two or three in number. The two constant ones are found on either side of the median line on the caudal part of the dorsum. The third one when present is behind the first two. Rarely a 4th is found
- Besides the other papillae, another variety called *foliate papillae* are situated just in front of the cranial pillars of the soft palate where they form a rounded eminence marked by transverse fissures. This variety contains numerous taste buds
- The tongue is not so protractile as in the ox and is not prehensile
- Muscles are less developed

TONGUE (PIG)

- Long and narrow and the apex is thin. Fraenum linguae are double
- Only 2-3 circumvallate papillae are present
- Torus linguae is absent
- Filiform papillae are soft
- At the dorsal surface of the root there are a good number of caudally directed papillae

TONGUE (DOG)

- It is wide and thin in front and thicker caudally
- It is not pigmented but has a bright red colour
- The dorsum presents median sulcus linguae
- The filiform papillae are found on the entire dorsum
- The fungiform papillae are present on the dorsum and sides are absent in the root
- The vallate papillae are 2 or 3 on either side on the caudal part of the dorsum. Small foliate papillae are present as in the horse
- In the inferior part of the tip of the tongue is the lyssa, a fusiform cord, composed of fibrous tissue, muscular tissue and fat

TONGUE (RABBIT AND FOWL)

Rabbit

- The tongue is comparatively thin
- The tip is blunt
- It possesses filiform, fungiform, vallate and foliate papillae
- The vallate papillae are few in number
- The root presents a wide and white coloured prominence, which extends upto the middle of the tongue at the dorsal surface

Fowl

- It is narrow and triangular and the apex is pointed in front
- Muscular tissue is very little
- The root presents a transverse row of pointed horny papillae whose apices are directed backwards

TEETH (OX)

- The teeth are hard, white or yellowish-white structures implanted in the alveoli of the jaws
- They are organs of prehension, mastication and sometime of defence
- The domestic mammals have two sets of teeth

- The teeth of the first set appearing in the early life are known as the *milk or deciduous teeth* (temporary) and these are replaced later during the period of growth by permanent teeth
- According to their position they are classified as,
    - Incisors or cutting teeth are implanted, in front in the alveoli of the premaxilla and mandible
    - Canines which are situated a little backwards.
    - Premolars and molars (cheek teeth) - forming the sides of the dental arch.
- The complete dentition of an animal can be expressed in a condensed form in a dental formula
- In this formula letters indicate the kind of teeth and the figures above and below express the number of teeth in the upper and lower jaws on each side
- The individual teeth are designated numerically beginning from the midline as first, second and so on
- The canines are known as fangs or tusks. The vestigial first premolar is known as wolf tooth.
- *The dental formula for the Ox is* 2 (**I** –0/4 C – 0/0 **PM** – 3/3 **M** – 3/3) = 32

Parts of tooth

- Each tooth presents for description a part above the gums the crown, and a part inside the gums and embedded in the alveolus is known as the root or fang
- The line of union of the crown and root is the neck. The crown is made up of dentine covered over by enamel
- The root, which is embedded in the alveolus, consists of dentine and covered by cementum
- The surface of the tooth by which it is in contact with the tooth of the opposite jaw is the table or grinding surface
- The surface facing towards the lip is the labial surface, towards the tongue is the lingual surface and towards the cheek is the buccal surface
- Simple and complex teeth - Simple tooth is one, the crown of which is covered by the enamel
- A complex tooth is one, where the enamel covering the crown forms one or more invaginations on the table.

Teeth are composed of 4 tissues from within outwards

- Pulp, dentine cement and enamel
    - The pulp of the tooth is a soft gelatinous tissue, which occupies the pulp cavity, in the centre of the tooth
    - The pulp is well supplied with blood vessels and nerves. In growing tooth, it is very extensive but decreases as age advances
    - The dentine is ivory like and forms the bulk of the tooth and covers the pulp
    - It is hard and yellowish white
    - The enamel is the hardest tissue in the body and covers the dentine of the crown
    - It is clear and bluish white in colour and forms the protective covering over the teeth
    - The cement or crusto petrosa covers the dentine of the root
    - The root of the tooth is firmly attached to the alveolus by a vascular layer of connective tissue the alveolar periosteum (Periodontal membrane)

TYPES OF TOOTH
(OX, Sheep & Goat, Horse,Pig, Dog, Rabbit, Fowl)

Brachyodent tooth

- They are simple, unspecialized tooth consists of conical crown, a slightly constricted neck and a simple conical root.

Hypsodent tooth

- These are more specialized tooth where in crown and neck are not easily distinguished and there is only a body and root.

Isognathus and anisognathus

- Isognathus animals with equal upper and lower jaw width whereas the lower jaw is narrower than the upper jaw is called as

Ox

- The incisors are absent in the upper jaw. There are 8 incisors in the lower jaw arranged in a fan-like manner
- They are all simple teeth and have no infundibula. The crown is white, sharp and shovel-shaped. Each presents labial and lingual surfaces separated by a sharp edge in front
- The crown is at first entirely covered with enamel but later as the masticatory surface is developed the dentine comes into view on the surface
- The root is rounded and is embedded in the jaw as to allow a small amount of movement. Neck is very distinct
- The incisors are termed as centrals, *intermediates, laterals and corners* of which the corners are probably *canines*
- The incisors do not undergo continued eruption but the length of the crown is maintained by retraction of the gums
- The deciduous incisors are smaller and the crown is narrower and the canines are absent.
- The cheek teeth are made up of three premolars and three molars in each side of upper and lower jaws
- They are small but they show gradual increase in size from first to the last. The enamel folds on the tables are prominent
- The tables are not flat but oblique. The upper teeth are longer on the outside and the lower ones on the inside

TOP

Sheep and Goat

- Same as ox.
- The incisor teeth form a narrow and strongly curved arch
- The crown is long and narrow
- Their labial surfaces are strongly convex and end at a sharp edge, which is used, in chopping the grass
- The roots are more firmly embedded than ox
- The cheek teeth resemble ox but have a thinner layer of cement, which is often blackened by deposits from the food

TOP

Horse

- The formula for the permanent teeth of horse is, 2 (I.3/3 C.I/I P.M. 3 or 4/3, M 3/3)=40 or 42.
- ***Incisors:*** They are twelve in number, six in each jaw placed close together so that their lateral edges form almost a semi circle in the young horse. These teeth have the peculiarity of presenting instead of the simple cap of enamel on the crown, a deep invagination -the *infundibulum* that becomes filled up with cement. Hence as the tooth wears the table has a central ring of enamel surrounding the infundibulum in addition the peripheral enamel. The cavity becomes darkened and is termed *the cup or infundibulum mark*.
- Each tooth is so curved as to present a convex lateral surface and the embedded part of the teeth converge. The tooth tapers from the crown to the root regularly so that there is no distinct neck. In young horse, the masticatory surface is broad transversely towards the middle of the tooth, the two diameters are about equal and near the apex, and the antero-caudal diameter is considerably greater than the transverse diameter.
- This fact is of value in the determination of age since the masticatory surface at different ages represent a series of cross sections. As the crown wear down, the embedded part emerges from the alveolus so that the tables of the first and second incisors are at first oval, with the long diameter transverse; at old age the tables are triangular, the base being at the labial edge. At the same time, the infundibula become smaller with age, approach the lingual border and finally disappear. Another important feature is one of the progressive approaches to the horizontal direction of the teeth as age advances. They become parallel and even convergent.
- *Canines:* They are four in number in the male and rudimentary or absent in the mare. The upper canines are at junction of the premaxilla, the lower ones being nearer to the comer incisors. They are slightly curved with concavity directed inwards. The embedded part is round and the pulp cavity is large.
- *Cheek teeth:* They are twenty-four, twelve in each jaw. Sometimes there is a first premolar in the upper jaw - wolf tooth and rarely a corresponding one in the lower jaw.
- The cheek teeth are large, prismatic in form and quadrilateral in section except the first and last, which are three sided. The crown is long and most of it is embedded and erupts as the part wears away.

- The upper cheek teeth are embedded in the alveolar processes of the maxilla
- They are slightly curved with the convexity towards the cheek. The embedded parts diverge. The buccal surface presents a central ridge and two grooves
- The lingual surface presents wide rounded ridge separating two grooves
- The masticatory face presents two infundibula. It slopes downwards and outwards so that the buccal edge is prominent and sharp
- The first and last have three roots and others three or four. The roots of the last three and sometimes that of the third also project into the maxillary sinus.
- The lower cheek teeth are implanted in the rami of the mandible, forming two straight rows
- The buccal surface has a longitudinal furrow
- The lingual face is uneven having 3 or more grooves
- The masticatory surface is oblique, slopes upwards and inwards so that the lingual edge is prominent. The first five have two roots, and the sixth has three
- Two infundibula run through the entire length of the crown
- The temporary teeth are smaller, present a distinct neck, crown is very short, infundibula are shallow. The canines do not erup

TOP

Pig

- The dental formula is 2(I. 3/3 C. 1/1 P.M. 4/4 M. 3/3)=42
- The upper incisors are small and separated by each other by spaces and from the canines by a large interval
- The first incisors are the largest
- The lower incisors are horizontal and convergent and close together
- The canines or tusks of the male are greatly developed and project out of the teeth
- The upper one is 3-4 inches whereas the lower one is 8 inches
- The cheek teeth increase in size from before backward

TOP

Dog

- The dental formula is 2 (I. 3/3 C. 1/1 P.M. 4/4 M. 2/3) = 42
- The incisors are placed vertically and close together
- They do not correspond to an opposing tooth but to parts of two teeth of the opposite jaw like the dovetail
- The canines are large, conical and curved. The upper canine is separated from the comer incisor by an interval into which the lower canine is received
- The lower canine is close to the comer incisor
- The cheek teeth are 6/7 and the masticatory surfaces are tuberculate, having conical projections
- The fourth of the upper row and fifth of lower row are much larger than the rest and are termed *carnassial or sectorial teeth*

TOP

Rabbit

- The dental formula is 2(I 2/1 C 0/0 P 3/2 M 3/3)
- Each half of the upper jaw has two sharp chisel incisors
- The larger one is situated in front and the smaller one is placed behind, as if to support the larger one

TOP

Fowl

- Teeth are absent

SALIVARY GLANDS

- There are 3 pairs of salivary glands situated on the sides of the face and the adjacent part of the neck,
  - The parotid
  - Mandibular or submaxillary and
  - Sublingual
- Of these, the parotid gland is of serous type, while the other two are of the mixed type

PAROTID SALIVARY GLAND
(Ox, Sheep & Goat, Horse, Pig, Dog, Rabbit)

Ox (View image)

- The parotid gland is situated below the ear in the space between the ramus of the mandible and the wing of atlas, overlapping the caudal part of the masseter muscle
- It has the form of a very narrow triangle with its base upwards. It is light red brown in colour and weighs about 115 gm
- It presents for description two surfaces, two borders, a base and an apex. The *lateral surface* is covered by the parotid fascia and the parotido-auricularis muscle
- It is crossed obliquely by the external jugular vein at its lower part. The *medial surface* is uneven and has many important relations -the great cornu of the hyoid bone, masseter, digastric and occipito-hyoideus muscles, tendons of brachio-cephalicus and sterno-cephalicus muscles, external carotid artery and its branches, facial nerve and its branch, pharyngeal lymph gland and the sub-maxillary salivary gland.
- The *cranial border* is closely attached to the masseter muscle and partly covers the parotid lymph gland
- The *caudal border* is concave and is loosely attached to the surrounding structures
- The *base* is superior and embraces the base of ear. The apex is bent forwards and fits in to the angle of union of the external jugular and external maxillary veins
- The *parotid duct or Stenson's duct* leaves the inferior part of the medial face of the gland and gains the medial face of the medial pterygoid muscle
- It runs forwards in the mandibular space below the external maxillary vein, winds round the inferior border of the horizontal ramus of the mandible passes upwards in company with the facial vessels situated behind them and in front of the cranial border of the masseter muscle and covered by the inferior buccal nerve or its communicating branch to the superior buccal
- It crosses the facial vessels and penetrates the cheek opposite to the upper fifth cheek tooth and opens on the summit of the *papilla salivalis*

TOP

Species difference

Sheep and Goat

- The gland is darker in colour and more compact in texture than the mandibular
- It is rounded in outline, but has a rounded cervical angle
- The duct leaves the lower part of the cranial border of the gland and runs forward over the masseter muscle about an inch and a half above the ventral border of the ramus
- It opens the third or fourth cheek tooth

TOP

Horse

- The parotid is the largest salivary gland and weighs about 200 to 225 gm
- It has a long quadrilateral outline
- It is yellowish-grey in colour
- Its medical face is related to the guttural pouch in addition to other structures
- The apex is above, embracing the base of the ear. The base is inferior and is related to the external maxillary vein
- The duct leaves the gland at its inferior part near the cranial border about one inch above the external maxillary vein
- It opens on the papilla salivalis about the level of the upper third cheek tooth

TOP

Pig

- It is large and distinctly triangular: its upper angle does not reach the base of the ear
- Pale in colour
- Parotid duct perforates the cheek opposite to the fourth or fifth upper cheek tooth
- Small accessory parotid glands may be found along the course of the duct

TOP

Dog (Click to see the salivary glands in dog)

- It is very small and irregularly triangular with its base upwards
- The apex overlaps the mandibular gland. The dorsal end (base) shows a deep notch
- The duct leaves the gland at the lower part of the cranial border, crosses the masseter muscle and opens into the mouth cavity opposite to the upper third cheek tooth
- Small accessory glands are sometimes present along the course of the duct

TOP

Rabbit

- It has three pairs of salivary glands – parotid, sublingual and infraorbital
- The parotid gland is large lying below the ear along the caudal border of the mandible
- The parotid duct opens behind upper incisors

SUBMAXILLARY OR MANDIBULAR SALIVARY GLAND
(OX, Sheep & Goat, Horse, Pig, Dog, Rabbit)

Ox (View image)

- It is the largest salivary gland and is pale yellow in colour and weighs about 140 gm. It is long, narrow and curved, the upper edge being concave
- It extends from the fossa atlantis to the body of the hyoid bone. It is partly covered by the parotid gland
- It presents two surfaces, two borders and two extremities. The *external surface* is covered by parotid gland, digastricus and internal pterygoid, muscles
- The *internal surface* is related to the rectus capitis ventralis major, laryngeal division of the carotid artery, the 10th and 11th cranial nerves and sympathetic nerves
- The *dorsal border* is concave and thin and the duct leaves the middle of this border. The *ventral border* is convex and thick
- The *caudal extremity* is loosely attached to the fossa atlantis. The *cranial extremity* is larger and rounded and lies at the side of the root of the tongue

- It is related to the mandibular lymph gland and is crossed laterally by the external maxillary artery. It is situated very close to the same part of the opposite gland
- The *mandibular duct (Wharton's duct)* leaves the middle of the concave border of the gland, runs forwards crossing the digastricus and stylo-hyoideus under genio-glossus, crosses under the hypoglossal nerve and gains the medial face of the sublingual gland
- It then runs forwards, under the mucous membrane of the mouth and opens on the *caruncula sublingualis or barb*

TOP

Species difference

Sheep and Goat

- As in ox

Horse

- It is smaller than parotid and weighs about 45 to 60 gm
- The duct passes between hyoglossus and mylohyoideus and gains the medial face of the sublingual salivary gland

TOP

Pig

- Small in outline and covered by parotid
- Its external surface is marked by rounded prominences
- The duct opens near the fraenum linguae, but there are no papillae

TOP

Dog (View image)

- It is larger than parotid
- It is rounded in outline and pale yellow in colour
- The duct leaves the gland from its internal surface, crosses the stylo-glossus and opens into the mouth on a very distinct papilla near the fraenum linguae

TOP

Rabbit

- It is lobulated lying caudal to the angle of jaw and ventral to the parotid salivary gland

SUBLINGUAL SALIVARY GLAND
(OX, Sheep & Goat, Horse, Pig, Dog, Rabbit, Fowl)

Ox (View image)

- The sublingual salivary gland lies beneath the mucous membrane of the floor of the mouth between the tongue and the horizontal ramus of the mandible
- It consists of two parts dorsal and ventral. The dorsal part extends from the cranial pillar of soft palate to the symphysis of the mandible

- It is long, thin and pale yellow in colour. The ventral part is shorter but thicker and lies ventral to the cranial portion of the dorsal part
- It is salmon pink in colour.The whole gland is compressed laterally
- The external surface is related to the mylo-hyoideus muscle and the internal surface to the genioglossus, mandibular duct and branches of lingual nerve
- The ventral border is related to the geniohyoid muscle. The dorsal border is under the mucous membrane of the floor of the mouth
- The dorsal part of the gland has several ducts, which are very tortuous and open between the papillae on the floor of the mouth
- The ventral part has a single duct, which opens either side on the caruncula sublingualis or joins the dorsal part of the Wharton's duct

TOP

Species difference

Sheep and Goat

- As in ox

Horse

- The gland extends from the mandibular symphysis to the fourth or fifth lower cheek tooth
- It weighs about 15 to 16 gms
- The ducts are numerous and open on small papillae on the sublingual fold

TOP

Pig

- The dorsal part is related to the mandibular gland and its duct
- The ventral part is much larger than dorsal part
- All or most of the ducts from the dorsal part unite to form the ductus sublingualis major, which open near the mandibular duct
- From the ventral part 8 or 10 ductus sublingualis minores convey the secretion through the floor of the mouth

TOP

Dog (View image)

- It is pink in colour and made up of the dorsal and ventral parts
- The dorsal is in intimate relation with the mandibular gland. Its duct accompanies the mandibular duct and opens along side or joins it
- The ventral part is long and narrow and has numerous ducts, which open into the mouth directly while others join the large duct
- The dog has another gland-the zygomatic gland. It is situated at the cranial part of the pterygo -palatine fossa. Superficially it is related to the zygomatic arch
- It has four or five ducts which opens near the last upper cheek tooth

TOP

Rabbit

- A small gland cranial to the submandibular gland and medial to the mandible. Thus gland is often confused with oval lymph nodes

- The infra orbital gland lies below the eye medial to the angle of jaw and its ducts open near the upper molars

TOP

Fowl

- A small round gland near the angle of the mouth is regarded by some as the homologue of parotid salivary gland
- The mandibular glands lie between the two halves of the mandible and their ducts open on the floor of the mouth by several ducts
- The maxillary glands lie in the roof of the mouth and they open on either side of the median ridge of the hard palate
- The palatine glands are medial and lateral and open on either side of the lateral ridges

MODULE-5: DIGESTIVE SYSTEM - PART III

Learning objectives

- To know about the clinical importance of pharynx
- To know about surgically important course of oesophagus
- To know about the visceral topography of neck

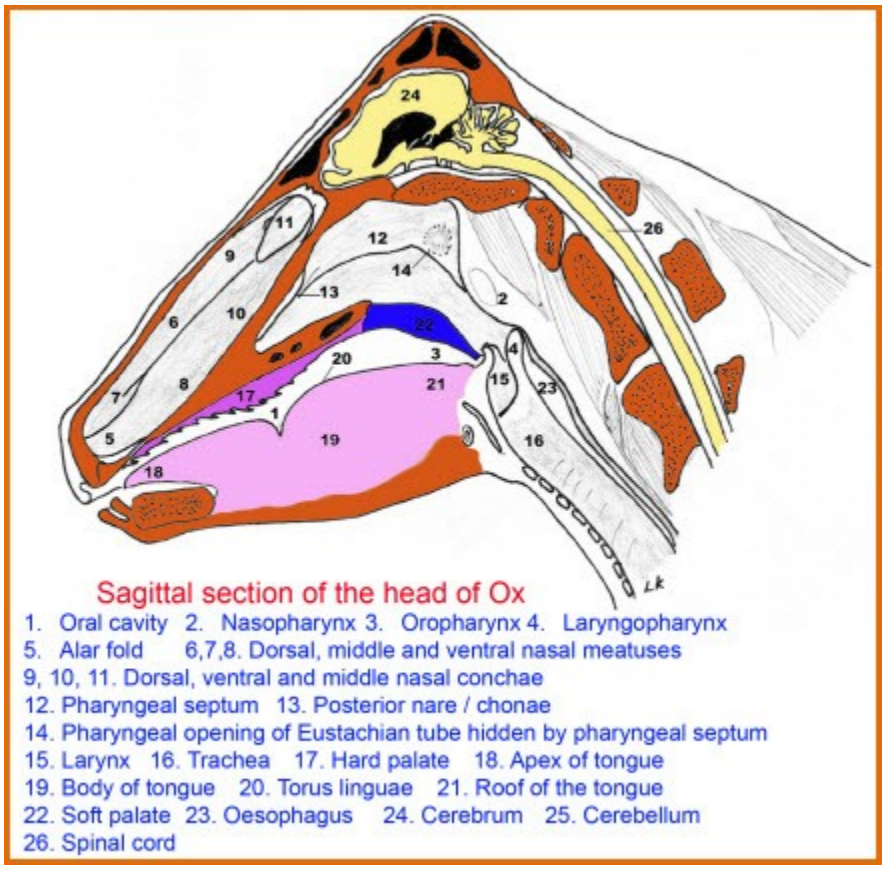
PHARYNX (OX)

Ox

- The pharynx is a musculo-membranous passage common to both the digestive and respiratory systems
- It is a funnel shaped organ, the broad end of which continuous with the mouth and nasal cavities, while the oesophagus continues the narrow portion
- It is directed obliquely downwards and backwards and is attached by muscles to the palatine, pterygoid and hyoid bones and to the cricoid and thyroid cartilages of larynx

Relations

- Dorsally the base of cranium and supra-pharyngeal lymph glands, and Ventrally the larynx, Laterally, the medial pterygoid muscles, great cornua of the hyoid bone, external carotid and external maxillary arteries, the glosso-pharyngeal, cranial laryngeal and hypoglossal nerves, mandibular salivary glands and para-pharyngeal lymph glands



The cavity of the pharynx presents seven openings

- *One and two* - Two caudal nares situated at the antero-dorsal part communicating with the nasal cavities
- *Three* - The Isthmus faucium below the caudal nares communicating with the mouth cavity
- *Four* - The auditus laryngis opening into the larynx
- *Five* - Auditus oesophagi opening into the oesophagus
- *Six and Seven* - Two Eustachian orifices behind the caudal nares at the dorso-caudal part communicating with the tympanic cavity of middle ear, through Eustachian tubes
- The vault or fornix on the roof of pharynx is divided here into two cul-de-sac by a median fold of mucous membrane., which is the continuation of the septum nasi
- *Structure*
    - Pharyngeal muscles
    - Aponeurosis - attached to the bones at the base of the cranium
    - Mucous membrane- continuous with that of the several cavities which opens into it

OESOPHAGUS
(Ox, Sheep, Goat, Horse, Pig, Dog, Rabbit, Fowl)

Ox

- It is a musculo-membranous tube, which extends from the pharynx to the stomach. It is divided into cervical and thoracic parts
- The *cervical part* begins at median line above the cranial border of the cricoid cartilage of larynx
- At the level of the fourth cervical vertebra, it passes to the left of the trachea and continues this relation on the left side of the neck and enters the thoracic cavity

- The *thoracic part* begins at the level of the first rib. At the level of third thoracic vertebra it gains the dorsal face of the trachea passes backwards and crosses the right side of aortic arch
- It continues its course through the mediastinum between the lungs backwards and slightly upwards inclines to the left, reaches the hiatus oesophagi of the diaphragm
- It passes through it and immediately terminates on the dome-like rumino-reticular wall -the atrium ventriculi
- *Directions* : At first downward and backward till the thoracic inlet; upward to the dorsal face of trachea backwards and upwards between the lungs
- *Relation at the origin* : Dorsally, the ventral straight muscles of the head. Ventrally cricoid cartilage. Laterally, carotid arteries
- *About the middle of the neck* : Dorsally, left longus colli. Medially, trachea. Laterally, Left carotid artery, vagus and sympathetic nerves and recurrent laryngeal nerve
- *In the thoracic cavity* In the *cranial mediastinum*: dorsally longus colli. Ventrally, trachea. Left side, Aorta, right side right vagus
- In the *caudal mediastinum*: Oesophageal trunks of vagus lie above and below it

Species difference

Sheep and Goat

- The lumen is about an inch when moderately distended
- Otherwise it resembles that of ox

Horse

- It is longer, being about 125 to 150 cm. It has a small abdominal part. At its origin it is related to the guttural pouches
- It is narrower and less dilatable
- The muscle is striped till the level of the base of the heart and plain thereafter. There is a short abdominal part of oesophagus, about 2 to 3 cm

Pig

- Short and nearly straight
- The potential caliber is wide
- Except the terminal part the muscular coat is striated
- It has a small abdominal part
- There are numerous tubulo-alveolar glands are present in the cranial part of the tube

Dog

- Wide and relatively more dilatable except at the origin where there is a constriction
- Muscular tissue is striated

TOP

Rabbit

- The tube is 8 cm long and thin walled
- The cervical part is longer than the thoracic part
- It has a considerable length of abdominal part, which is little more than 1cm

Fowl

- It extends from the pharynx to the proventriculus

- It is greatly dilatable
- It is at first dorsal to the trachea, then inclines to the right and presents at the thoracic inlet a ventral dilatation called the crop. Both inlet and outlet are on the internal face of the crop
- It joins the cranial extremity of the proventriculus

MODULE-6: RUMINANT STOMACH

Learning objectives

- To know about the clinical anatomy and nutritional anatomy of ruminant digestive system
- To know about the regional anatomy in the abdominal cavity

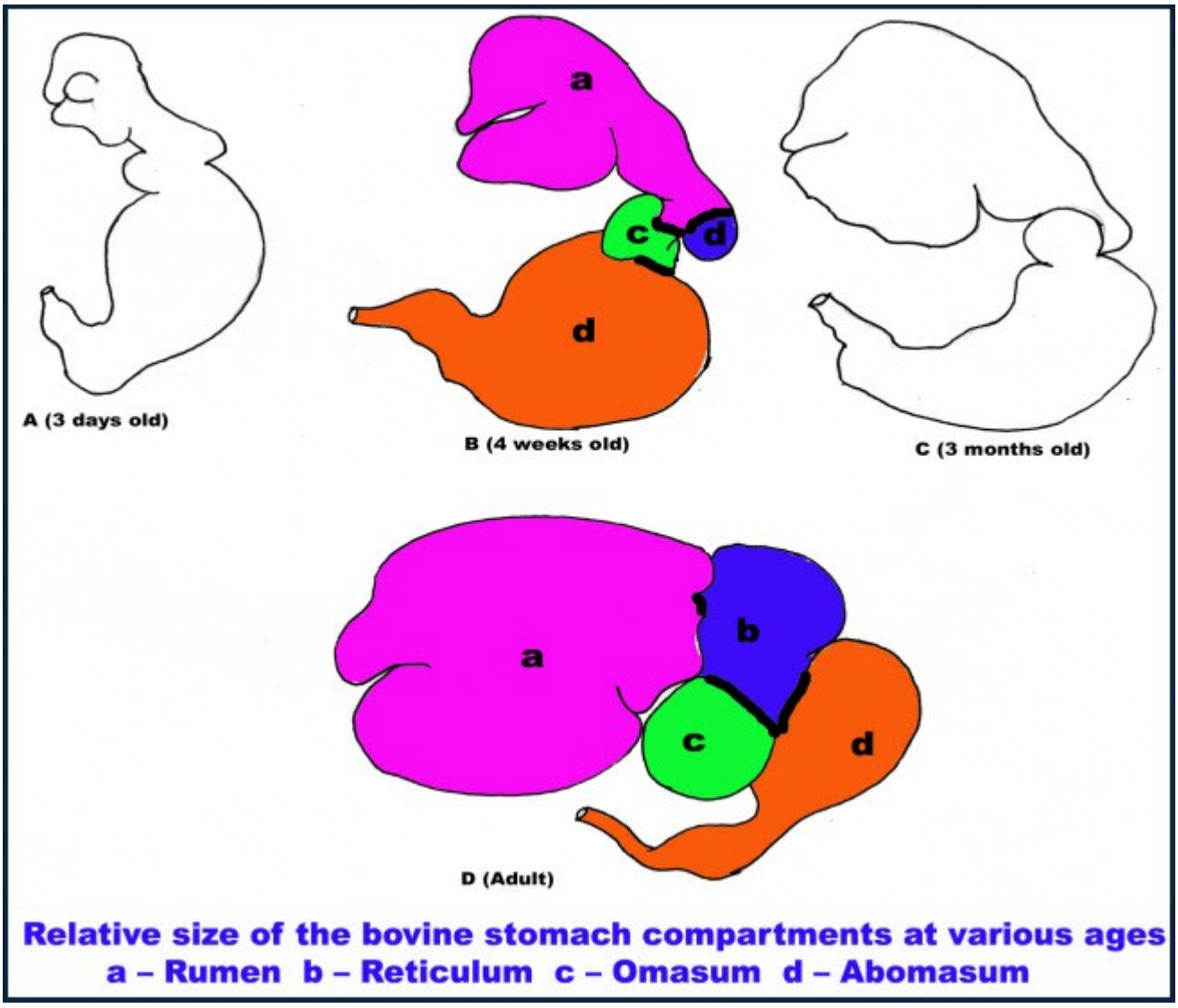
EXTERIOR OF RUMINANT STOMACH

Ox

- The stomach of the ox is very large and occupies nearly three-fourth of the abdominal cavity
- It completely fills up the left of the abdomen except for a space intended for the spleen and extends considerably into the right half
- It has four compartments,
    - Rumen (*paunch*)
    - Reticulum (*honeycomb*)
    - Omasum -(*many folds, many plies or psalterium*) and
    - Abomasum, (*rennet or true stomach*). The division is indicated by grooves

Capacity

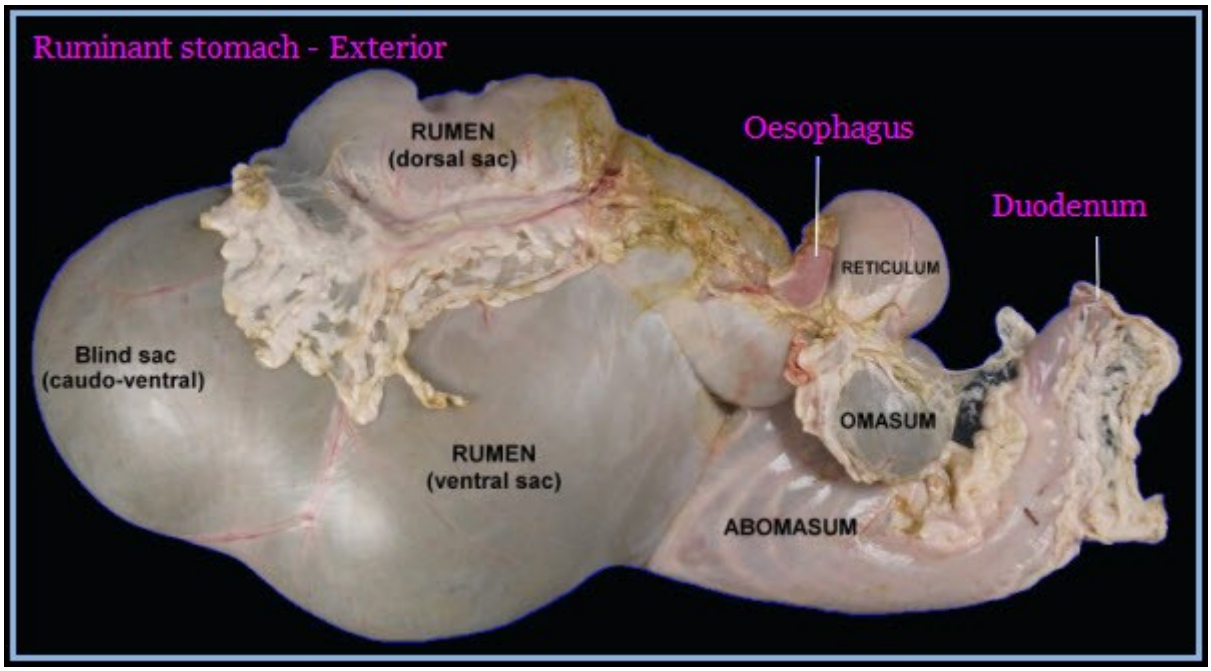
- Varies according to the age, size, breed, etc. Medium size is 30 or 40 gallons



- In the new born the first and second are about half of the fourth. At 10 to 12 weeks the ratio is reversed
- At four months rumen and reticulum are 4 times as large as other two compartments
- At 1 1/2 years omasum equals abomasum, rumen 80%, reticulum 5%, Omasum 7 to 8%, abomasum 8 or 7% (In adult)

RUMEN - EXTERIOR

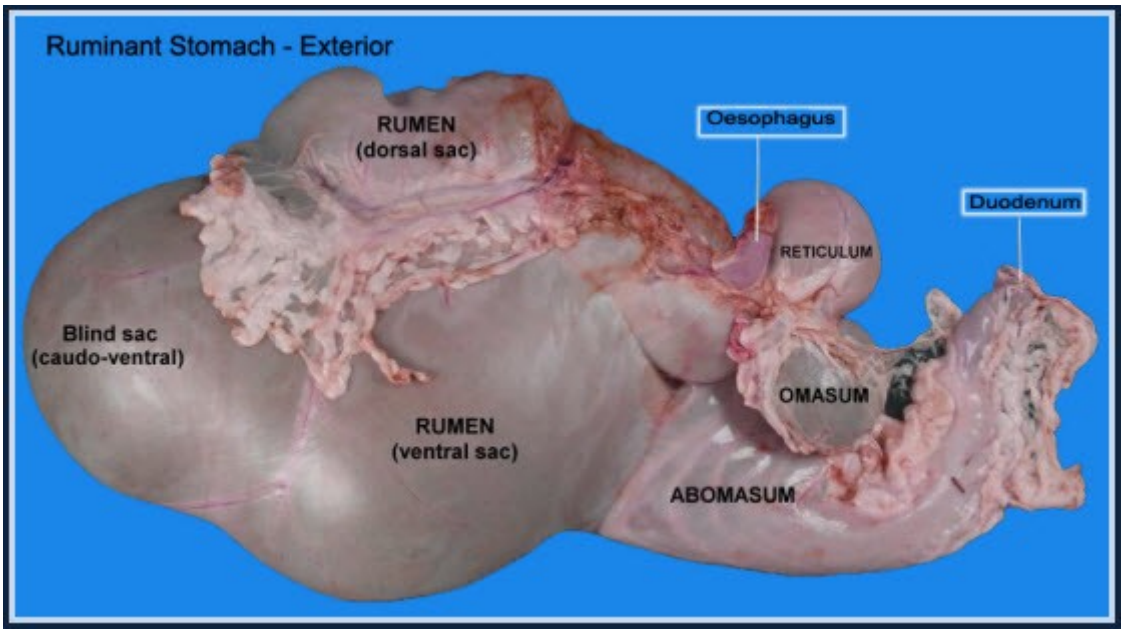
- The rumen occupies most of the left half of the abdomen and extends considerably over the median plane to the right
- It extends from the lower part of the 7th or 8th inter costal space to the pelvic inlet
- It is slightly compressed laterally and presents two surfaces, two borders and two extremities



- The *parietal surface* is convex and is related to the diaphragm, left wall of abdomen and spleen
- The *visceral surface* is irregular and is related to the omasum, abomasum, intestine, liver, pancreas, left kidney, adrenal, aorta and caudal vena cava
- The *dorsal curvature* is convex and is in contact with the dorsal wall and attached to it by peritoneum and connective tissue as far back as fourth lumbar vertebra
- The *ventral curvature* is also convex and is related to the floor of the abdominal cavity
- The two surfaces are marked by right and left longitudinal grooves dividing it into dorsal and ventral sacs
- The *cranial extremity* is divided ventrally by a transverse groove into two sacs - *dorsal and ventral,* of which the dorsal one becomes continuous with the reticulum, curves over the ventral sac, which is rounded and blind
- The junction of the dorsal sac and reticulum is marked by a groove, the *rumino reticular groove* that is distinct ventrally, the two compartments form a sort of dome - the atrium ventriculi on which the oesophagus terminates
- The *caudal extremity* extends to the pubis and is related to the intestine and bladder
- It is divided by the deep caudal transverse groove into dorsal and ventral sacs both of which are blind
- The grooves lodge the vessels and nerves of the rumen

RETICULUM - EXTERIOR

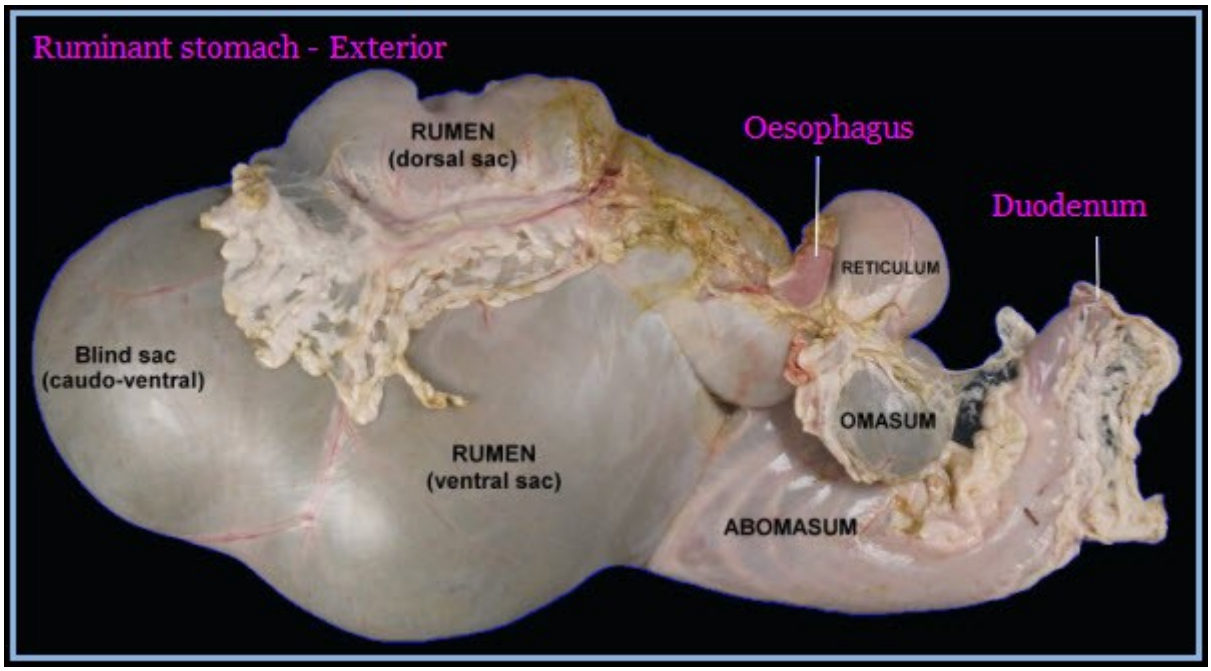
- The *reticulum* is the most cranial and smallest of the four compartments
- It extends from the 6th to the 8th ribs
- The greater part of it is to the left of the median line. It is compressed from before backwards
- The *parietal surface* faces forwards, convex and lies against the diaphragm and liver
- The *visceral surface* faces backwards, is flattened and ends dorsally by joining the rumen, the concave line of junction corresponding to the ridge in the interior, forms the lower margin of the rumino-reticular orifice



- The *lesser curvature* faces to the right and dorsally and is connected with the omasum. The *greater curvature* faces to the left and is ventral
- The right extremity forms a rounded blind sac *(fundus reticuli),* which is in contact with the liver, omasum and abomasum and lies opposite to the sixth intercostal space

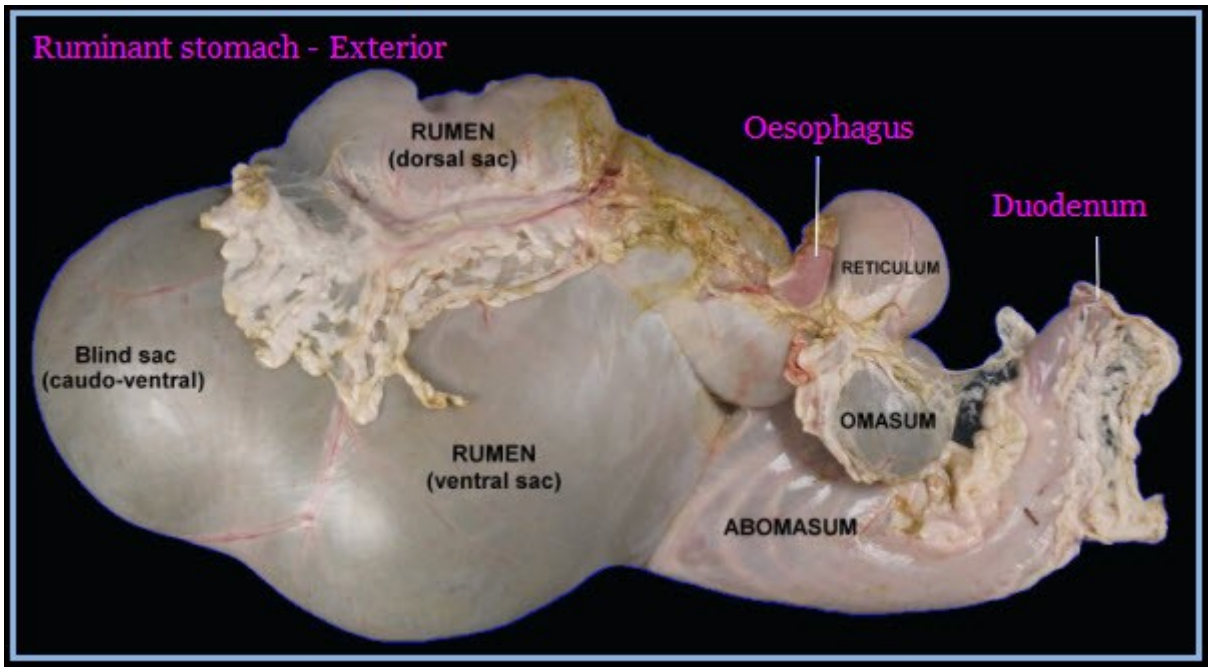
OMASUM

- The *omasum* is ellipsoidal in form and is somewhat compressed between the two surfaces
- It is very clearly marked off from the other compartments and lies to the right of median line from the 7th to the 11th rib
- The *parietal surface* faces to the right and forwards and is related to the diaphragm and liver
- The visceral surface faces to the left end backwards and is in contact with right face of rumen, reticulum and abomasum
- The *greater curvature* faces backwards and to the right. The lesser curvature is very short and faces forward and to the left
- It is connected at its upper part with the reticulum. Below it joins the abomasum



ABOMASUM

- The *abomasum* is an elongated sac, which lies on the abdominal floor from the xiphoid cartilage backwards
- The *cranial blind end* is at the xiphoid region in relation with the reticulum
- The *body* extends back between the ventral sac of rumen and the omasum and turns to the right behind the omasum
- It is constricted about the middle forming an cranial larger part and a caudal pear shaped smaller part
- The pyloric part inclines dorsally and joins the duodenum at the ventral part of the 10th rib
- The *parietal surface* is in contact with the abdominal floor. The *visceral surface* is related to the rumen and omasum
- The greater curvature gives attachment to the superficial part of the greater omentum
- The lesser curvature is related to the greater curvature of the omasum

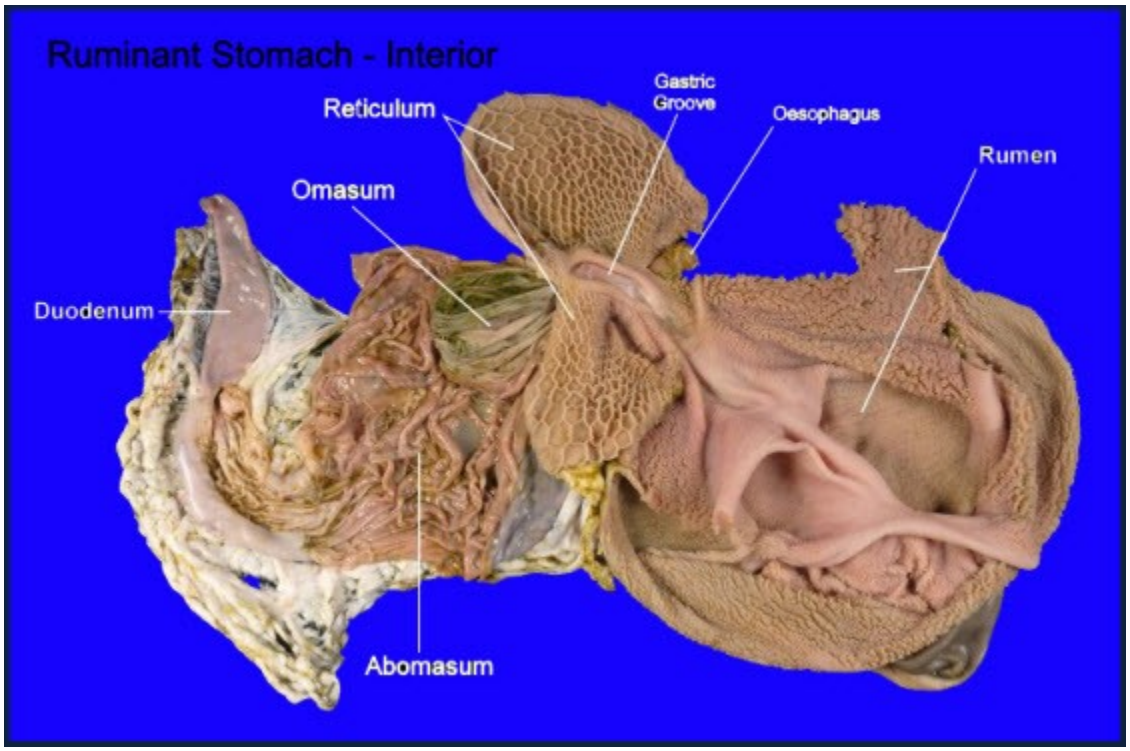


INTERIOR OF RUMINANT STOMACH

- The different compartments of the ruminant stomach differ in order to accomplish its function

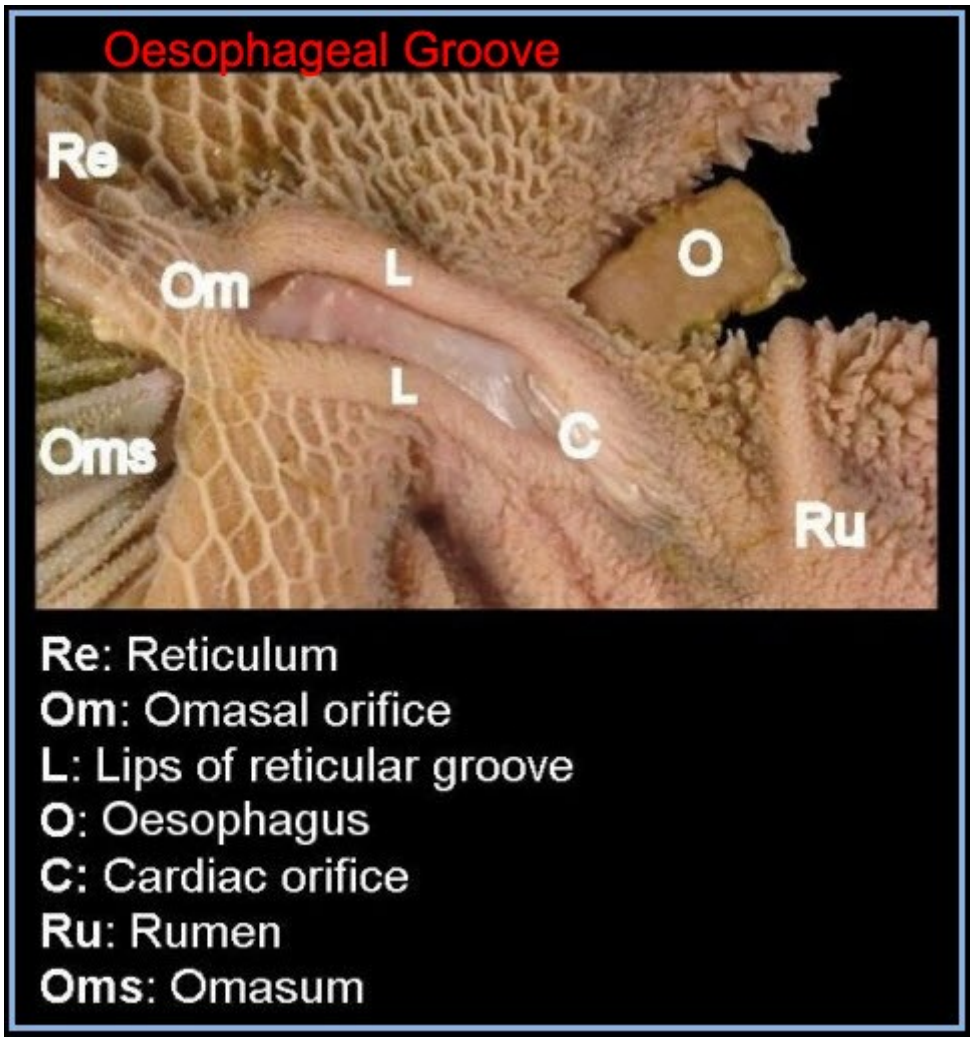
INTERIOR STOMACH - RUMEN

- The cavity of the rumen is divided into two sacs by the *pillars of the rumen*, which are muscular folds and correspond to the grooves on the exterior
- They project like shelves into the cavity of the organ. The cranial pillar has a thick concave free edge
- Between these free edges, the two sacs of rumen communicate with each other
- The right and left pillars connect the cranial and caudal pillars and are less prominent
- The *rumino-reticular fold* corresponds to the rumino-reticular groove. Its free edge is concave and forms the ventral and lateral margins of the large oval rumino-reticular aperture
- The cardia is about 10 to 12 cm ventral to the vertebral end of the 8th or 9th rib. The opening is slit-like
- The mucous membrane is brown in colour except on the pillars where it is pale
- It is thickly studded with papillae which are however not present on the pillars.



OESOPHAGEAL GROOVE

- The *reticular or oesophageal groove* is formed by two muscular ridges or lips extending from the cardia to the reticulo -omasal opening



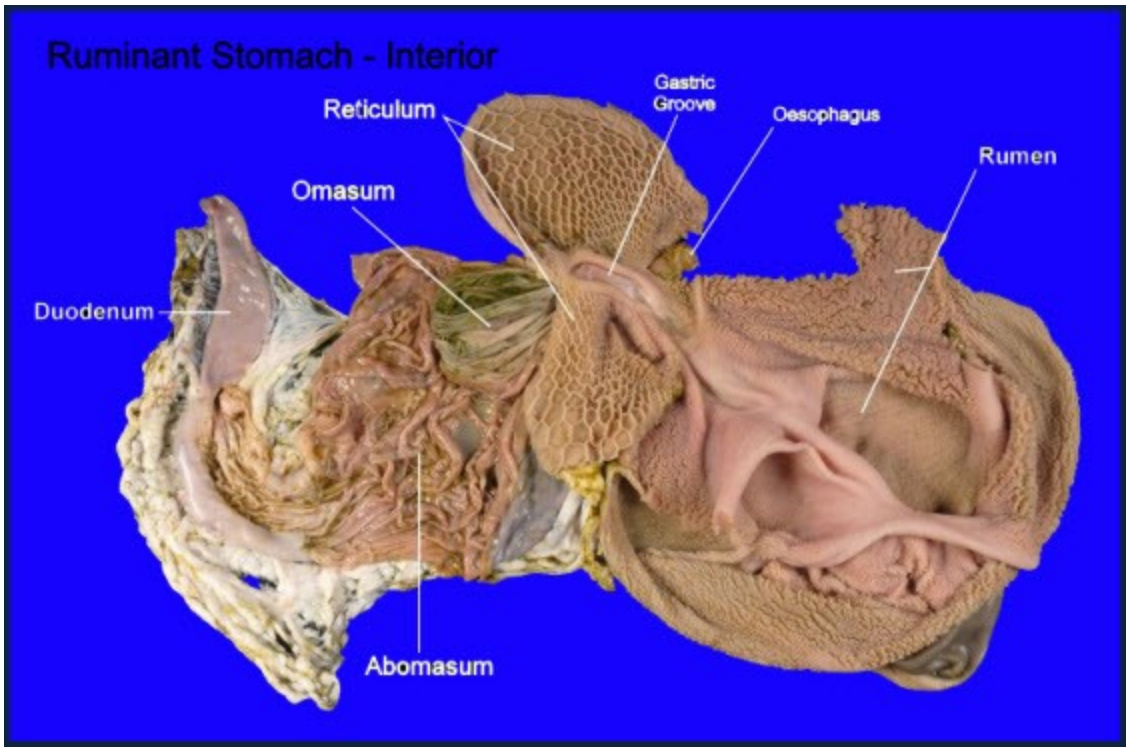
- It is about 18 to 20 cm length. Its direction is chiefly dorso-ventral but usually it inclines somewhat forward and medially in its ventral part
- The groove is twisted in spiral fashion so that its thickened edges project at first backward then to the left and finally forwards
- The twist mainly concerns the left lip
- The two lips meet dorsal to the cardiac opening and pass ventrally along the right wall of the reticulum, the right lip twisting around the left lip

INTERIOR STOMACH - RETICULUM

- The interior of the reticulum is raised into folds of about 1/2 inch high enclosing 4 to 6 sided spaces or cells (Honey - comb)
- Smaller folds subdivide these cells and bottoms are studded with pointed horny papillae
- The reticulo-omasal orifice is situated at the lesser curvature of the reticulum five or six inches above the bottom of the later and is rounded

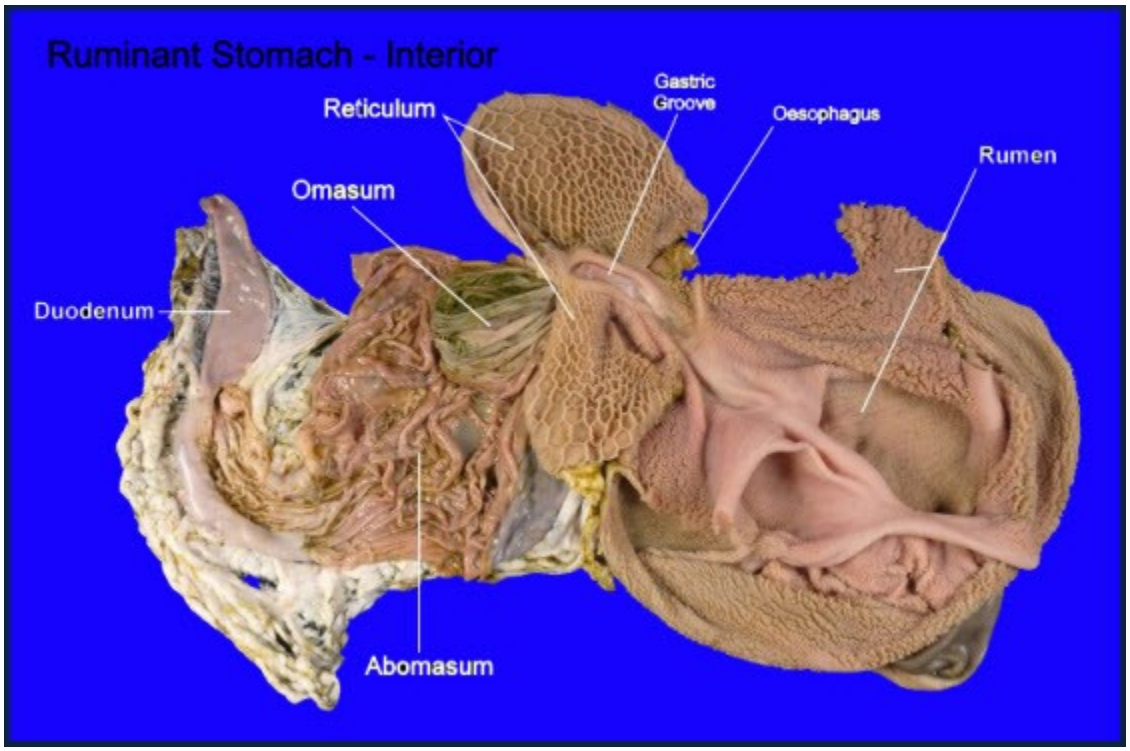
INTERIOR STOMACH - OMASUM

- The cavity of omasum is occupied by about hundred longitudinal muscular folds - the *lamina omasi,* which spring from the greater curvature
- The largest of these are about half a dozen in number, have a superior convex attached edge and a thick concave free edge
- A groove *sulcus omasi* extends from the reticulo-omasal opening to the omaso-abomasal opening and is about 4 inches long
- It is free from laminae. The omaso-abomasal orifice is oval and is about 4 inches long



INTERIOR STOMACH - ABOMASUM

- The cavity of the abomasum is divided into two parts by a constriction
- The first part is lined with soft glandular epithelium forming about a dozen or more spiral folds
- The second part is narrower and pear-shaped and presents a brownish mucous membrane
- The pylorus is small and round



STOMACH (SHEEP AND GOAT)

- The stomach of sheep and Goat generally resembles that of ox with the few differences

EXTERIOR - STOMACH (SHEEP AND GOAT)

- Generally resembles that of ox
- The rumen has the average capacity is 18 litres
- The cardia is opposite to the 8 th intercostal space; it is just to the left of the median plane and about 2 inches below the vertebral column
- The dorsal sac of the rumen is longer than the ventral one
- The ventral sac is larger and its volume extends to the right of the plane than in ox
- Its caudal blind sac extends further back than that of the dorsal sac
- The reticulum is relatively larger than the ox. Its ventral part curves more backward and less to the right than in ox
- Omasum is much smaller than the reticulum, the capacity being 1 pint
- It is situated on the opposite to 9 th or 10 th ribs higher than ox
- The abomasum is relatively larger and longer than in ox

INTERIOR - STOMACH (SHEEP AND GOAT)

- In rumen the papillae are larger and tongue like and the dorsal part is papillated, not glabrous as in ox
- The reticular groove in general like that of ox and about 4-5 inches long, and have serrated edges
- In the omasum, the laminae are less numerous than in ox
- In the neck, which connects the omasum with reticulum, they have the form of low, thick ridges and bear long pointed horny papillae

MODULE-7: NON-RUMINANT STOMACH

Learning objectives

- To know about the monogastric feature of the concerned domestic animals
- To have supportive knowledge on the locative macro anatomy of stomach

EXTERIOR - STOMACH (HORSE)

- The stomach is in the form of a simple saccular structure The capacity is about 12 litres
- It is placed at the left side on the median line on the dorsal aspect of the abdomen behind liver and diaphragm
- It is curved and J shaped sac
- The lesser curvature is short. The cardia and pylorus are very close
- At the left extremity of the stomach, close to the entrance of the oesophagus, there is a rounded cul-de-sac known as saccus caecus
- The pyloric end is comparatively smaller
- The right extremity is smaller and is continued by the duodenum. It is attached by,
    - Gastrophrenic ligament
    - Greater omentum
    - Gastrosplenic omentum
    - Lesser omentum
    - Gastropancreatic fold

INTERIOR - STOMACH (HORSE)

- The mucous membrane is divided into oesophageal (non-glandular) and glandular parts, which are separated by a rough
- The glandular part is divided into cardiac, fundic and pyloric regions according to the presence of different types of glands in the mucous membrane
- The part on the left extremity is non-glandular being the extension of the oesophageal mucous membrane-oesophageal region and the remaining is glandular
- The glandular part is subdivided into three zones, according to the type of glands present, but no distinct line of demarcation exists
- A narrow zone along the margoplicatus is the cardiac gland region
- Adjacent to it is the large fundic gland region
- Remainder of the mucous membrane is the pyloric gland region

EXTERIOR - STOMACH (PIG)

- The stomach is simple and comparatively large
- Capacity is 6 litres.
- The left part is large and presents a conical diverticulum the *diverticulum ventriculi*
- When full, its long axis is transverse and its greater curvature extends on the floor of the abdomen, midway between xiphoid cartilage and the umbilicus
- The cardiac opening is slit like and is bounded by a fold

INTERIOR - STOMACH (PIG)

- Mucous membrane is divided into four regions
- Over the quadrilateral area around the cardia, it is glandless and presents a number of folds

- A sharp line demarcates this above area from the rest of the mucous membrane
- The cardiac gland region is pale grey in colour and extends about the middle of the stomach.
- The fundus gland is distinguished by its thickness and mottled appearance
- The pyloric region is thinner and presents a number of irregular folds
- At the pylorus, a remarkable prominence, *the torus pyloricus* projects from the wall of the lesser curvature

STOMACH (DOG)

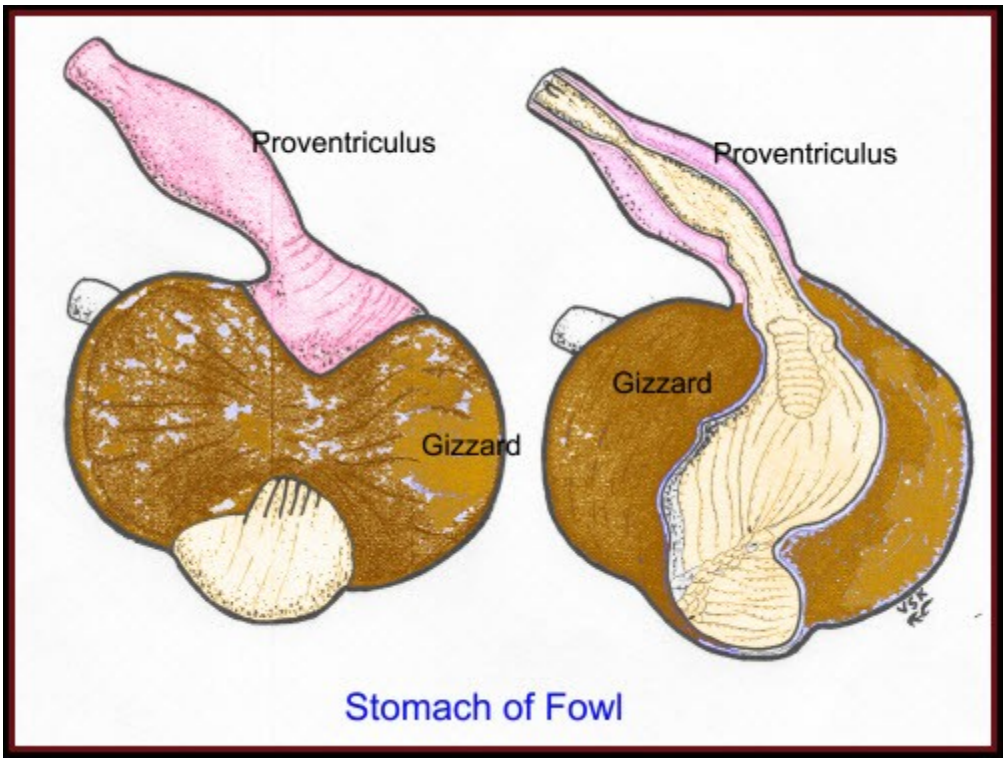
- Capacity is about 3 litres. When full it is pyriform in shape
- The left part is large and rounded while the right part is small and cylindrical
- The parietal surface is extensive, convex, faces forwards, downwards and to the left
- It is related to the liver; diaphragm and left ventral and lateral abdominal wall as far as the level of the 2nd or 3rd lumbar vertebra
- The visceral surface is less extensive and is related to the intestine, pancreas and left kidney
- The lesser curvature is nearly straight above but below it makes a sharp bend forming an angle
- The greater curvature is extensive and it extends, when the stomach is full behind the costal arch
- Ventrally it lies on the abdominal floor about midway-between xiphoid cartilage and pubis

STOMACH (RABBIT)

- It is simple in structure
- The fundic part is comparatively big
- The pyloric part is well–developed and connected with the fundic part by a wide constriction
- The volume is 40-50 ml
- The wall of the pyloric part is thick and bears few transverse folds

STOMACH - FOWL

- It is made up of two parts
    - Proventriculus *(glandular)* and
    - Gizzard (*muscular)*



- The *proventriculus* is an elongated fusiform thin walled tubular organ, related laterally and ventrally to the liver and the spleen at its supero-caudal aspect
- It is connected in front with the oesophagus and behind with the gizzard
- Its mucous membrane is lined by glandular epithelium
- The *gizzard or muscular stomach* is a thick walled muscular disc with two orifices placed close together on the antero-dorsal aspect of its circumference
- It is situated behind and partly between the two lobes of the liver
- The mucous membrane, lining the gizzard is thrown into ridges and is covered by dense horny substance, secreted by the glands lying beneath the epithelium

MODULE-8: INTESTINES

Learning objectives

- To know about the small and large intestine - Clinical and surgically important locations, topography, coiling and its attachments

SMALL INTESTINE (OX)

- The small intestine measures about 21.5 m. in the adult (Indian ox) and has a diameter of about 5 to 6 cm
- It begins at the pylorus and terminates at the caecum. It is divisible into a *fixed part and a mesenteric part*
- The fixed part is duodenum and mesenteric part is arbitrarily divided into jejunum and ileum

- The duodenum is about 1m long. It begins at the pylorus at the ventral end of the 10th rib
- The *first part* passes upwards to the visceral surface of the liver. Here it forms a 'S' shaped curve
- The *second part* runs backwards to the tuber coxae where it turns forward forming the iliac flexure.
- The *third part* extends forward in contact with the terminal part of the colon and joins the mesenteric part

- It is attached to the liver by the lesser omentum, to the remainder of its extent by the *mesoduodenum* -a narrow fold derived from the right layer of the mesentery
- The bile duct opens into the convexity of the ventral part of the 'S' shaped curve
- The pancreatic duct opens about 30 cm further back
- The remaining part of the small intestine, the *jejunum* is arranged in numerous very close coils, which form a festoon at the edge of the mesentery
- It lies chiefly in the space bounded medially by the right face of the rumen, laterally and-below the large intestine and in front the terminal part leaves the edge of the mesentery runs forwards between the caecum
- The last 120 cm constitutes the *ileum*
- In the interior, lymphoid tissue occurs in the form of distinct nodules, which are either scattered - *Solitary glands* or in groups - *Payer's patches*
- The Payer's patches are large and are about 18 to 40 in number; in calves 35 to 50. Usually there is a very long patch close to the ileo-caecal valve

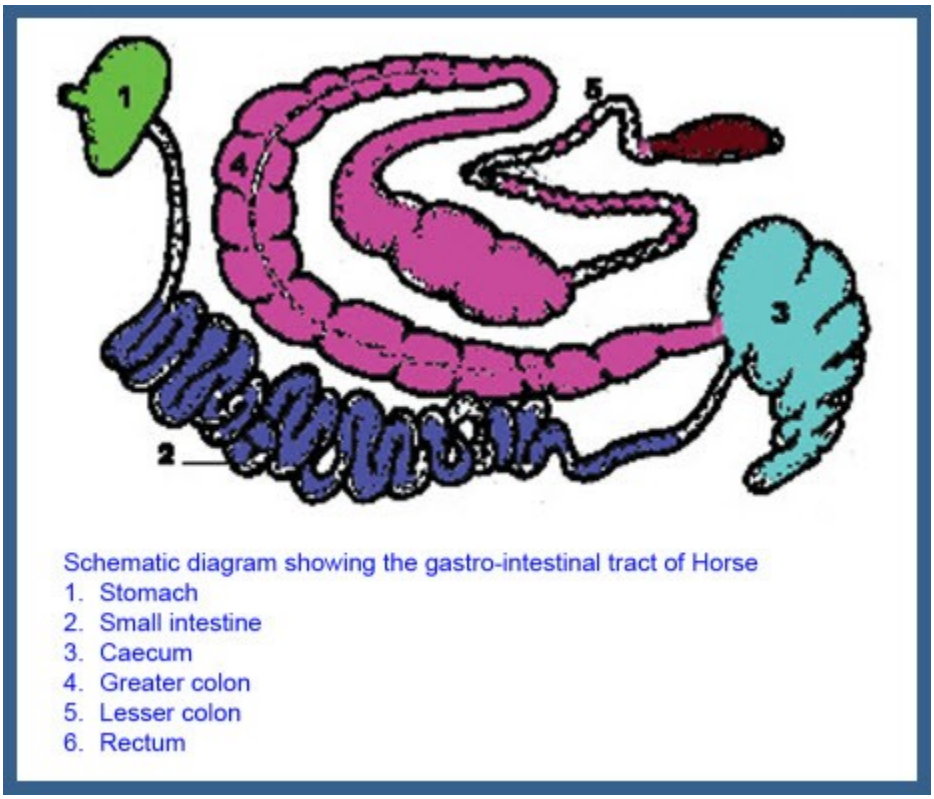
MESENTRY (OX)

- The mesentery is a *fan-shaped double peritoneum* containing the vessels and nerves to the intestine
- The visceral border is attached to the intestine and contains the mesenteric lymph glands while the parietal border or root is attached to a small area around the cranial mesenteric artery under the first and second lumbar vertebrae, the mesentery is at first short but soon reaches a length of 30 to 60 cm, sufficient to allow the intestine to reach the abdominal floor

SMALL INTESTINE (SHEEP AND GOAT)

- The general structure resembles that of Ox
- The small intestine is about 80 feet long with an inch average diameter
- The caliber is increasing in its terminal part, where a very extensive payer's patches are found

SMALL INTESTINE (HORSE)



Schematic diagram showing the gastro-intestinal tract of Horse

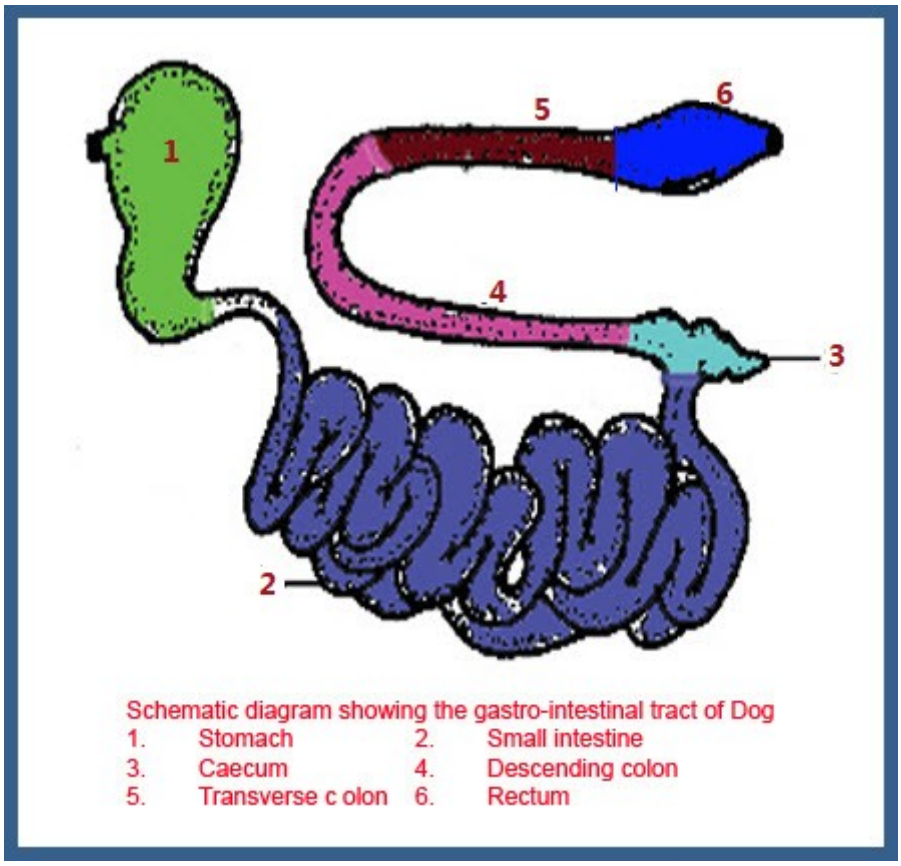
1. Stomach
2. Small intestine
3. Caecum
4. Greater colon
5. Lesser colon
6. Rectum

- Length is about 22 m. and diameter 7.5 to 10 cm
- The duodenum is somewhat like a horseshoe and the convexity is directed towards the right and it is about 1 m
    - The first part forms an 'S' shaped curve in contact with middle and right lobes of the liver, the bile and pancreatic ducts open about 12 to 15cm from the pylorus
    - The second part passes over the right dorsal colon and ventral to the right lobes of the liver to the right kidney and caecum and curves inwards to the -median line
    - The third part turns to the left behind the base of the caecum crosses behind the root of the great mesentery to continue forwards as the mesenteric part
    - The jejuno-ileum lies in numerous coils mingled with those of the small colon in the dorsal part of the left wall of abdomen from the visceral surface of the stomach to the pelvis
    - The ileum passes to the medial face of the caecum and opens into the lesser curvature of its base
- The mucous membrane forms a pouch -the diverticulum duodeni 12 to 15 cm from the pylorus where the bile duct and major pancreatic ducts open.
- On a small papilla opposite this level is the opening of the accessory pancreatic duct
- The root of the mesentery presents the mesenteric lymph glands
- Payer's patches are found on the surface opposite to the mesenteric attachment
- Intestinal and solitary glands are found throughout, Bruner's glands are found in the first 6 to 7 m. or more

SMALL INTESTINE (PIG)

- In the duodenum, *a descending part, a caudal flexure and an ascending part*
- The first part turns medially on the visceral surface of the liver
- The second part passes backwards in relation with the right kidney dorsally and colon ventrally and about the middle of the sub-lumbar region passes forwards to be continued as the mesenteric part of the intestine
- Bile duct opening is one or two inches from the pylorus and that of the pancreatic duct about 4 - 5 inches beyond it
- The jejunum is long and comprises of numerous small loops supported by mesentery
- The loops are placed at the right aspect of the abdominal cavity, dorsal to the colon caecum
- The ileum opens into the caecum at ileo colic junction and numerous lymph glands are present at the root

SMALL INTESTINE (DOG)



Schematic diagram showing the gastro-intestinal tract of Dog

1.	Stomach	2.	Small intestine
3.	Caecum	4.	Descending colon
5.	Transverse c olon	6.	Rectum

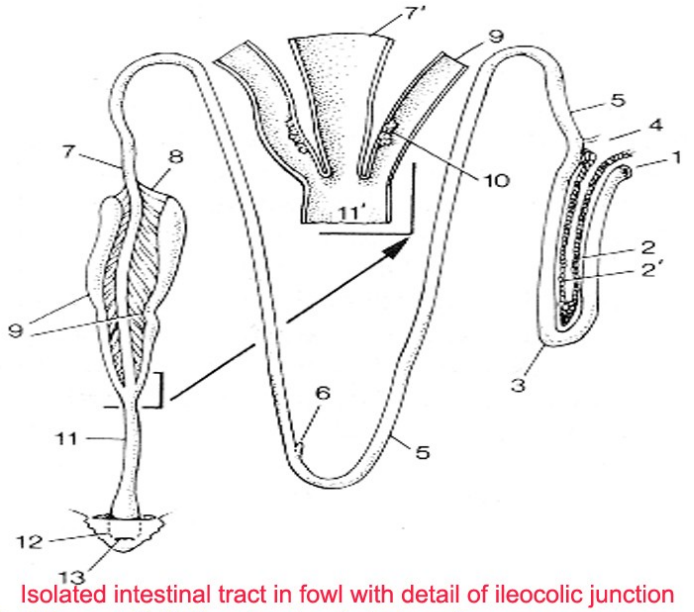
- Length is 4 m
- It is situated in the abdominal cavity filling up all the space behind liver and stomach
- The duodenum begins at the pylorus, passes backwards and upwards first on the visceral face of the liver and then in contact with the right flank to the pelvic inlet
- Here it turns inwards, passes forwards along the medial aspect of the left colon and at the left kidney bends downward and joins the jejunum
- The remainder of the small intestine forms numerous coils and attached by the wide mesentery to the sublumbar region
- The terminal part passes forwards along the medial face of the caecum and opens into the colon at the ileo-colic orifice
- The bile duct and minor pancreatic ducts open into the duodenum about 5 to 8 cm from the pylorus
- The major pancreatic duct opens 2.5 cm further back
- Payer's patches are numerous, elliptical and the last one is band like and reaches the end of the ileum

SMALL INTESTINE (RABBIT)

- The duodenum is long tube and presenting a *descending part, a caudal flexure and an ascending part*
- The caudal flexure comprises of a few U shaped loops. Bile duct and pancreatic ducts open into the duodenum separately
- The jejunum composed of a number of close loops. It has a length of about 2 meters
- The jejunal loops are situated above the caecum and behind the stomach and liver
- The ileum is the straight part of the tube and has a length of about 15cm close to the ilio caecal junction, the terminal part of the tube is dilated. This is known as *sacculus rotundus*

SMALL INTESTINE (FOWL)

- The small intestine is made up of duodenum, jejunum and ileum
- The duodenum leaves the gizzard passes backwards to the right and forms a loop, the flexure being at the caudal part of the abdominal cavity
- It continues forward past its origin to be continued as jejuno-ileum coiled between the abdominal air sacs
- The two bile ducts and two pancreatic ducts empty near each other at the termination of the duodenum



Isolated intestinal tract in fowl with detail of ileocolic junction
1. Pylorus 2, 2'. Dorsal and ventral lobes of pancreas
3. Duodenal loop 4. Bile and pancreatic ducts entering duodenum
5. Jejunum 6. Meckels divertiuclum 7. Ileum 7'. Ileum opened
8. Ileocaecal fold 9. Caeca 9'. Caeca opened 10. Caecal tonsil
11. Colon 11'. Colon opened 12. Cloaca 13. Vent

Fowl Small intestine

LARGE INTESTINE

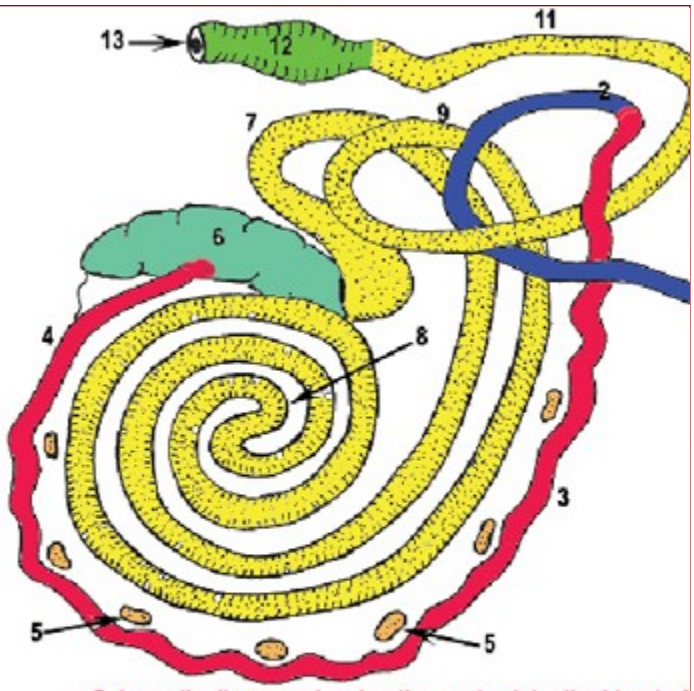
- Large intestine in domestic animals consists of caecum, colon and rectum

LARGE INTESTINE (OX)

- The large intestine extends from the termination of the ileum to the anus and measures 10 to 11.4 m
- It is situated between right and left layers of the mesentery in the right dorsal part of the abdominal cavity related on its left to the rumen
- It is divided into 3 parts - caecum, colon and rectum

CAECUM (OX)

- The caecum is a great cul-de-sac intercalated between the small intestine and colon
- It measures about 75 cm in length and the diameter is about 12 cm

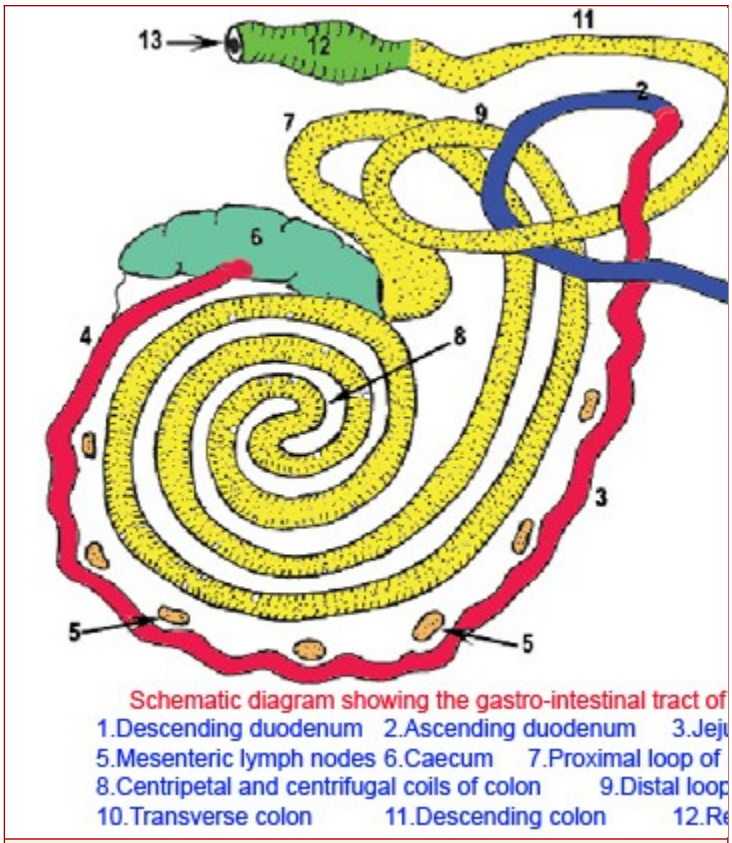


GI tract - Ox

- It is directly continuous in front with the colon, the conventional line of demarcation being the junction of the ileum with the large intestine
- From this junction on the medial face of the caecum at the ventral end of the last rib, the caecum extends backwards and upwards along the right flank and its rounded blind end commonly lies at the pelvic inlet

COLON (OX)

- The colon is about 10 m. in length
- It has at first a diameter of about 4 inches but later on gradually becomes smaller to about 5 cm
- The greater part of it is arranged in double elliptical coils between the layers of the mesentery
- It begins as direct continuation of the caecum, runs forwards for a short distance, and then turns upwards and backwards in relation to the right flank laterally and caecum ventrally to the caudal part of the sublumbar region
- Here it again turns forwards and runs parallel to the second part of the duodenum as far as second lumbar, turn backward and are continued by the coiled spiral part
- The coils are alternatively centripetal and centrifugal

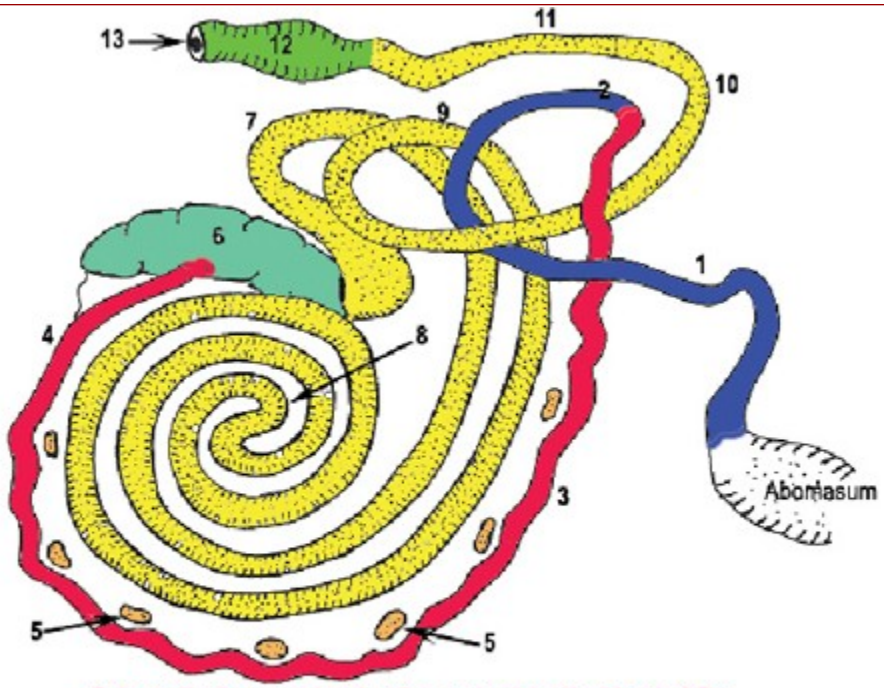


GI tract - Ox

- It gradually diminishes in its diameter and the terminal part leaves the spiral mass, passes forward to the root of the cranial mesenteric artery and runs backwards dorsal to the third part of the duodenum forming a loop round the artery as it's axis
- It inclines to the right, related to the ventral face of the right kidney and form an S-shaped curve near the pelvic inlet and joins the ectum
- This part is attached by a short mesocolon to the sublumbar region.

RECTUM (OX)

- The *rectum* is the terminal part of the bowel
- It extends from the pelvic inlet to the anus
- It measures about one foot
- The rectum runs almost straight or slightly oblique course through the pelvic cavity
- It is related dorsally to the roof of the pelvic cavity, ventrally to the bladder, vesiculae seminalis, vas deferentia, ureters, Cowper's glands and urethra in the male or uterus and vagina in the female.
- The cranial part of rectum, till about the level of the first coccygeal vertebra is covered by peritoneum and is attached by the mesorectum to the roof of the pelvis
- The caudal part is not covered by peritoneum and presents a dilatation, *ampulla recti*



Schematic diagram showing the gastro-intestinal tract of Ox

1.Descending duodenum 2.Ascending duodenum 3.Jejunum 4.Ileum
5.Mesenteric lymph nodes 6.Caecum 7.Proximal loop of colon
8.Centripetal and centrifugal coils of colon 9.Distal loop of colon
10.Transverse colon 11.Descending colon 12.Rectum 13.Anus

GI tract - Ox

ANUS

- The anus is the terminal part of the alimentary canal placed below the root of the tail forming a rounded projection with a central depression when contracted
- It is covered externally by thin skin devoid of hair but provided with numerous sweat and sebaceous glands
- It's lumen, the anal canal is about 5 cm long and is always closed by the contraction of the sphincter muscles and folds of the mucous membrane except during defecation
- The mucous membrane is pale, glandless and covered with thick squamous stratified epithelium
- *The muscles of the anus are,*
    - The sphincter ani internus is the terminal thickening of the circular coat of the bowel and the sphincter ani externus is a broad ring of striped muscle outside the preceding
    - The action of both is to close the anus
    - The retractor ani is flat striped muscle, which lies between the rectum and the sacro sciatic ligament ending below the preceding
    - It reduces the partial prolapse, which the anus undergoes during defecation
    - The suspensory ligament of the anus is a band of plain muscle arising from the first coccygeal vertebra, passing down under the retractor, unites with its fellow below the anus
    - In the male it is continued as retractor penis muscle. In the female it blends with the constrictor vulvae
    - Mucous membrane presents intestinal gland but no villi: solitary glands are numerous.

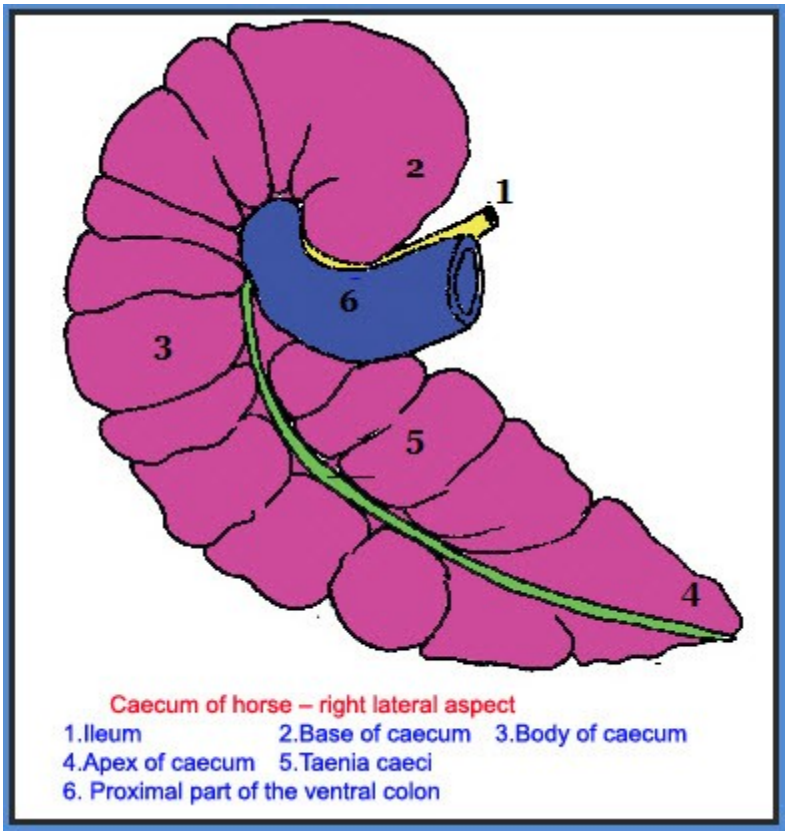
LARGE INTESTINE (HORSE)

- Length 7.5 to 8 m
- It differs from the small intestine with the following features
    - In being sacculated
    - In possessing muscular bands

- Great size
- More fixed position

CAECUM (HORSE)

- The caecum is about 1.25 m long
- It is comma shaped and extends from the right iliac region through the right lumbar region to the abdominal floor behind the xiphoid cartilage
- It presents *a base, an apex and a body*

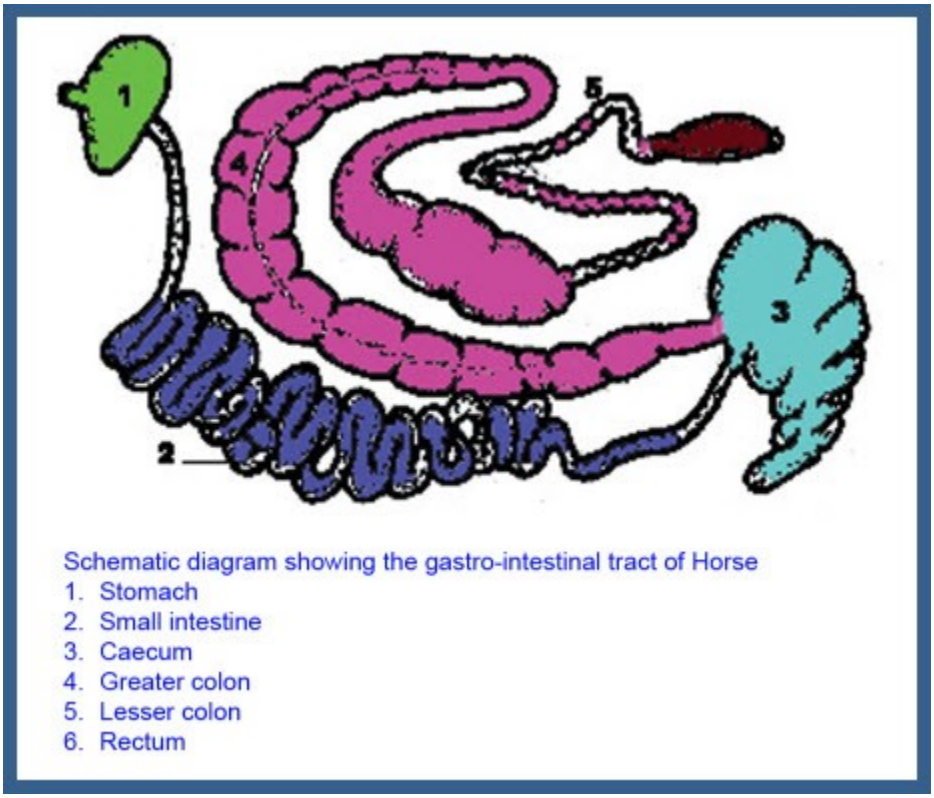


Caecum of horse – right lateral aspect
1.Ileum 2.Base of caecum 3.Body of caecum
4.Apex of caecum 5.Taenia caeci
6. Proximal part of the ventral colon

- Both extremities are blind and the ileo-caecal and caeco-colic orifices are placed close together on the lesser curvature of the base of the caecum
- The base is strongly curved
- The body is related on the right to the diaphragm, duodenum and liver and on the left to the terminal parts of the colon and small intestine
- The caecum has four longitudinal muscular bands

COLON AND RECTUM (HORSE)

Colon - Horse



Schematic diagram showing the gastro-intestinal tract of Horse

1. Stomach
2. Small intestine
3. Caecum
4. Greater colon
5. Lesser colon
6. Rectum

- Colon is divisible into greater colon and lesser colon based its diameter
- The greater colon begins at the caeco-colic orifice and ends by joining the small colon
- It is 3 to 3.7 m. long and has a diameter of 20 to 25 cm It consists of two parallel parts attached by folds and it is kept folded in the abdominal cavity so that it presents 4 parts
    - The *first part or the right ventral part* begins at the lesser curvature of the base of caecum, passes downwards and forwards and bends at the xiphoid cartilage of the left and backward forming the sternal flexure
    - The *second part or the left ventral part* passes backwards on the abdominal floor to the left of the first part of caecum, reaches the pelvic inlet and bends dorsally and forwards forming the pelvic flexure
    - The *third part or left dorsal part,* passes forwards dorsal to the second part, reaches the diaphragm and left lobe of the liver, turns to the right and backwards forming the diaphragmatic flexure
    - The *fourth part or the right dorsal part* passes backward dorsal to the first part, reaches the medial face of the base of caecum turns to the left and upwards behind the saccus caecus of the stomach, becomes constricted by the coils of the floating small colon
- *Diameter:* Ventral parts about 20 to 25 cm. Left dorsal about 8 to 9 cm Right dorsal about 50 cm
- *Muscular Bands:* Ventral parts have four bands. Left dorsal -1 at first and 2 added later on. Right dorsal - 3
- The lesser colon begins from the termination of great colon and lies in the form of coils in the space between the stomach and pelvic inlet dorsal to the left part of great colon
- Its length is about 3.5 m. and diameter about 7.5 to 10 cm
- They are mingled with those of the small intestine from which they can be distinguished by means of sacculations and the two muscular bands
- One of the bands is free; the other is concealed by mesentery
- It is attached to the sublumbar region by the colic mesentery
- The rectum is similar to that of the ox but is slightly larger

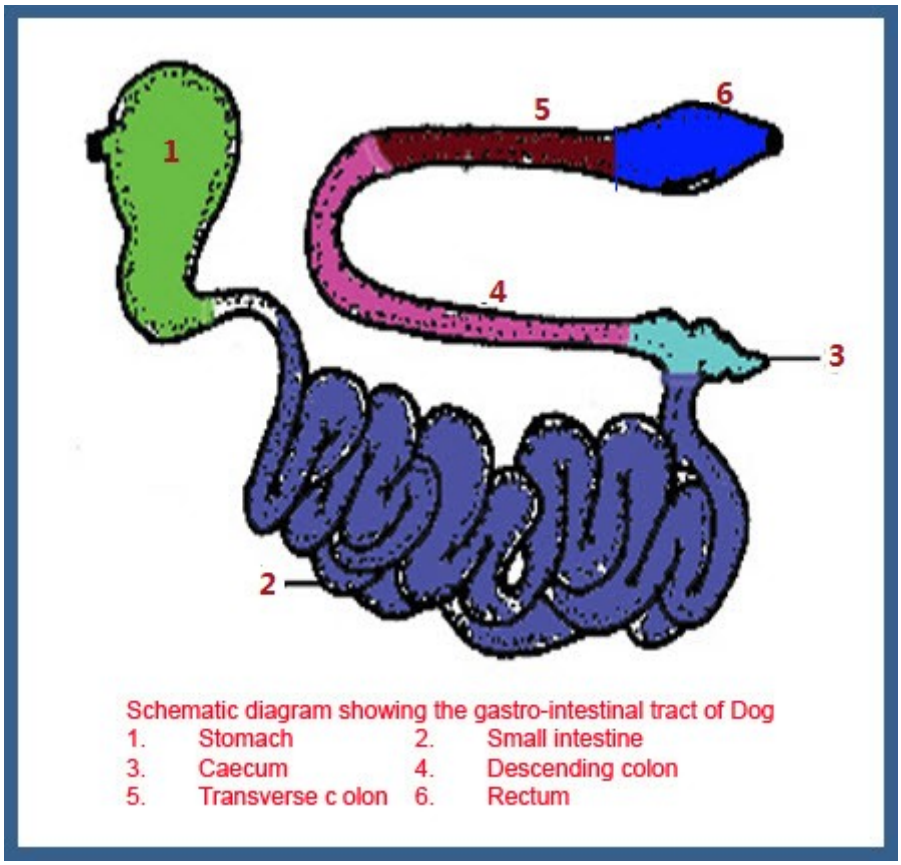
LARGE INTESTINE (PIG)

- The *caecum* is cylindrical

- It lies in the upper and cranial part of the left flank, and extends ventrally, backward and medially behind the coiled part of the colon, so that its ventral blind end usually lies on the floor of the abdomen near the median plane and at a variable point between the umbilicus and the pelvic inlet
- The caecum has three longitudinal muscular bands and three rows of sacculations, which is continued a short distance to the colon
- The solitary nodules are numerous and appear as round prominences. The ileum joins the caecum obliquely and projects considerably in to the latter
- A fold of mucous membrane called *frenulum ilei* passes from each side of the ileo-caecal opening
- The *colon* presents the ascending, transverse and descending parts
- The ascending colon has three wide centripetal coils, a central flexure and three narrow centrifugal coils
- The colon lies chiefly to the left of the median plane behind the stomach
- The *rectum* is surrounded by a quantity of fat

LARGE INTESTINE (DOG)

- It is 60 to 75 cm long. It has no bands or sacculations.
- The *caecum* is 12.5 to 15 cm It is situated midway between the right flank and median plane
- It extends as a blind diverticulum from the ileo-colic junction and is kept in a flexuous state by peritoneal folds. It opens cranially in to the colon.
- *Colon* is attached to the sublumbar region by the mesocolon
- It has three parts corresponding to the *ascending, transverse, and descending colon* of man
- The first-right part *(ascending)* is very short passing forwards medial to the duodenum, reaches the pyloric part of the stomach
- Here, it turns to the left crossing the median plane forming the *transverse part*
- The third-left part *(descending)* passes back in the sublumbar region ventral to the left kidney and inclines to the median plane to be continued as the rectum
- Colon is of uniform caliber throughout and is devoid of bands and sacculations.
- The *rectum* is completely covered with peritoneum. At the junction of the rectum and anus the mucous membrane has stratified squamous epithelium and contains the anal glands
- A small opening on either side leads into two lateral anal sacs of the size of a hazel nut containing a dirty grey fatty substance having a peculiar unpleasant odour.



Schematic diagram showing the gastro-intestinal tract of Dog

1.	Stomach	2.	Small intestine
3.	Caecum	4.	Descending colon
5.	Transverse c olon	6.	Rectum

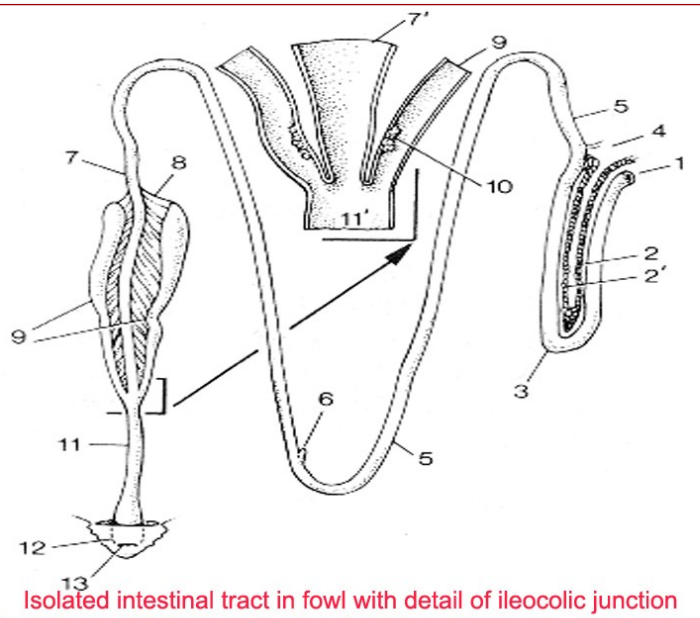
LARGE INTESTINE (RABBIT)

- *Caecum* is a wide sacculus long tube and occupies the whole of the ventral part of the right half of the abdominal cavity
- Length is about 55cm and possesses about 25 sacculations
- It remains coiled on itself and there fore comprises first, second, third and a blind terminal part
- The terminal part is slender and devoid of sacculations. This part is known as *vermiform appendix*
- Average diameter of the caecum is about 3cm
- The *colon* has an *ascending part, a transverse part and a descending part*
- Ascending colon begins from the base of the caecum in the form of a sacculated wide tube
- First 8-9 cm of ascending part bears taenae and sacculations on its wall
- The transverse colon is small and continues backward as descending colon
- It has constrictions and dilatations due to the presence of fecal balls in it

LARGE INTESTINE (FOWL)

- The large intestine consists of the two caeca and the colon. The line of demarcation between the ileum and the colon is at the openings of the caeca
- The *caeca* are two in number, left and right and are two blind tubes about 16 to 18 cm long extending from the ileo-colic junction on either side of it, forwards to the liver and are doubled on themselves
- They are connected with the gastro-intestinal tract at the junction between the ileum and colo-rectum
- Each of these tubular structures has a length of about 15cm
- They extend first cranially and then caudally parallel to the ileum
- Each caecum has *three parts-proximal, middle and distal*

- The proximal part is narrow and is connected with the intestine. Middle part is wide and the distal part is expanded
- The distal part terminates in the form of a pointed end. The wall contains lymphoid tissue, mostly at the proximal part. This lymphoid tissue is known as caecal tonsil
- The *colon or colo-rectum* is short straight tube, (without any demarcation between colon and rectum), extending backwards from the openings of caeca, to terminate behind at the cloaca.



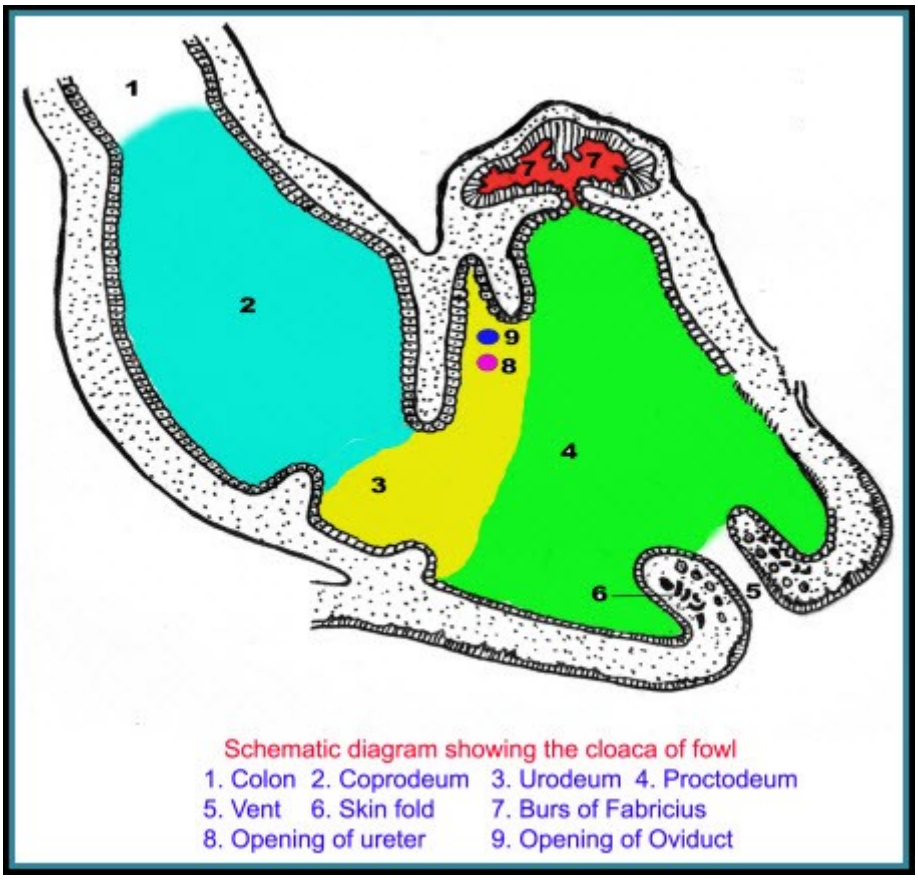
Isolated intestinal tract in fowl with detail of ileocolic junction

1. Pylorus 2, 2'. Dorsal and ventral lobes of pancreas
3. Duodenal loop 4. Bile and pancreatic ducts entering duodenum
5. Jejunum 6. Meckels divertiuclum 7. Ileum 7'. Ileum opened
8. Ileocaecal fold 9. Caeca 9'. Caeca opened 10. Caecal tonsil
11. Colon 11'. Colon opened 12. Cloaca 13. Vent

Fowl Small intestine

CLOACA (FOWL)

- The terminal part of the intestinal tract consists of three compartments separated by contractile folds of mucous membranes



- The *cloaca* is a tubular structure opening on the exterior, and is the common opening for the digestive, urinary and genital systems
- It is divisible into three parts; *coprodeum* into which the colon empties
- It is ampulla like dilated sac as the direct continuation of the colon
- It receives and temporarily holds the feces passed into it from the colon
- The next portion, the *urodeum*, it is less extensive compartment into which the two ureters open into the urodeum in both sexes and in males the seminal duct and in females through a slit-like aperture, the oviduct opens into this segment
- The last portion- the *proctodeum* is the short, most caudal segment of the cloaca, ends at the vent
- A small opening in its dorsal wall leads to the cloacal bursa. A small dorsal proctodeal gland is found caudal to the bursa
- *Vent* is the horizontal slit like opening of the proctodeum
- An opening leads from the dorsal wall to the *bursa of Fabricius* - a blind sac like unpaired structure found best developed in chicken about four months of age
- It usually disappears at one year of age.

MODULE-9: DIGESTIVE GLANDS

Learning objectives

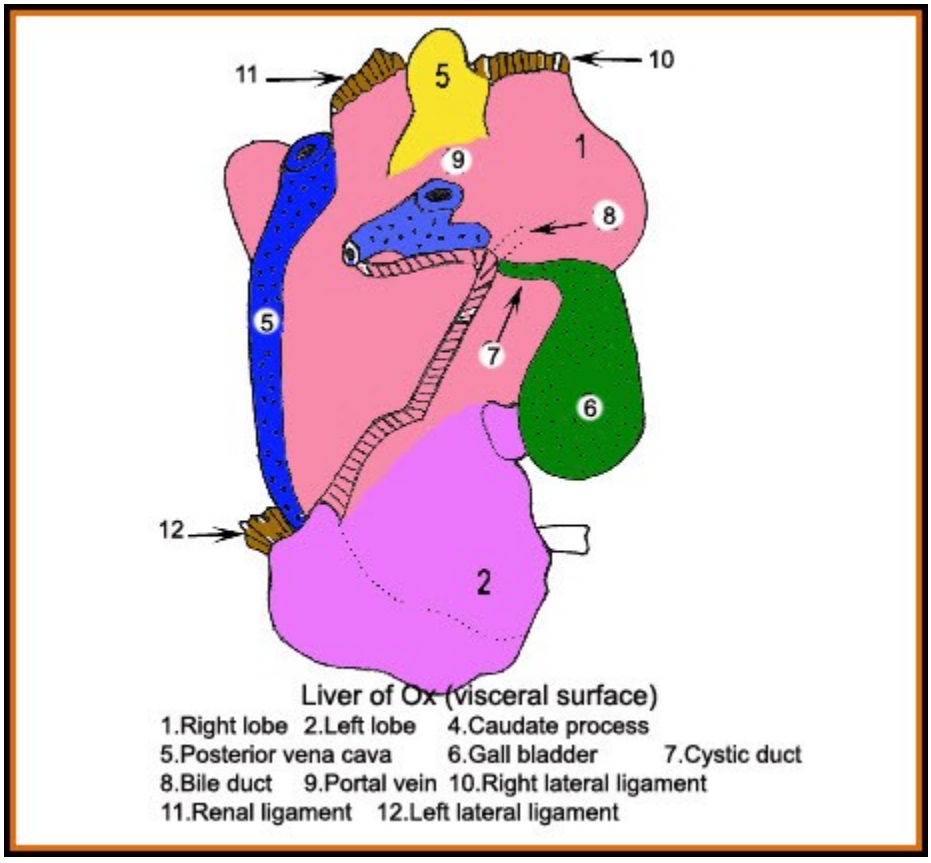
- To know about two important animate factories of digestive system i.e liver and pancreas - Location, attachment and extension

LIVER

- Liver is the largest gland in the body which occupies the abdominal cavity

LIVER (OX)

- The liver is the largest gland in the body
- It lies in the abdominal cavity almost entirely to the right of the median plane and extends obliquely downward and forward from the lumbo-costal angle to the level of 8 th rib.It is red brown in colour
- Its average weight is about 4.5 to 5.5 kg. It is strongly curved and is accurately adapted to the abdominal face of the diaphragm. It presents two faces and four borders
- The *parietal surface* is convex and is for the most part applied against the right part of the diaphragm and a small part of it is in direct contact with the last two ribs and flank at the lumbo -costal angle
- It is marked by an oblique ridge, which divides this face into two areas
- The falciform ligament is attached to this surface and extends from the oesophageal notch to the umbilical fissure
- A small area at the dorso medial part of this surface has no peritoneal covering as it is adherent to the diaphragm
- The *visceral surface* is concave and very irregular. It presents impression of the organs with which it is in contact
    - Omasal impression
    - Reticular impression
    - Cystic impression
    - The portal fissure is a well-defined depression situated dorsal to the omasal impression
    - It contains besides vessels, the bile duct and several large hepatic lymph glands. Dorsal and lateral to it, a part of the pancreas is attached



Liver of Ox (visceral surface)

1.Right lobe 2.Left lobe 4.Caudate process
5.Posterior vena cava 6.Gall bladder 7.Cystic duct
8.Bile duct 9.Portal vein 10.Right lateral ligament
11.Renal ligament 12.Left lateral ligament

- The *dorsal border* is short and thick. It presents the large, thick quadrilateral caudate lobe and a deep depression, renal impression of the right kidney and adrenal
- The *ventral border* is short and thin
- The *right border* is marked by the umbilical fissure in which the round ligament is attached
- The *left border* presents the oesophageal notch below its middle. Above this, the border is median in position and lodges the caudal vena cava, which is embedded in the gland

LIGAMENTS OF LIVER

- The right lateral attaches the dorsal border to the sublumbar region
- *Caudate ligament* attaches the caudate lobe to the ventral face of the right kidney
- The *falciform ligament* is a crecenteric fold, which attaches the sternal part of the diaphragm to the parietal surface of the liver
- The *round ligament,* which is in the free border of the falciform ligament, extends from the umbilical fissure to the umbilicus
- The lesser omentum attaches the liver from the oesophageal notch to the portal fissure with the parietal face of the omasum
- Cranial face is adherent to the diaphragm
- The caudal vena cava embedded in its left border holds it in position

GALL BLADDER

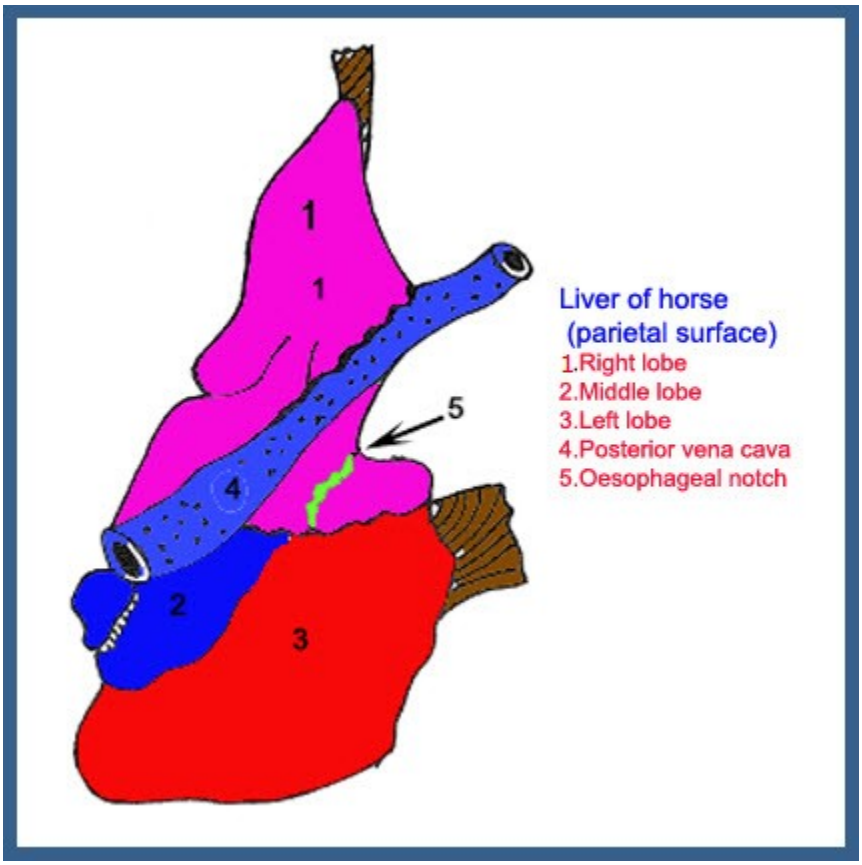
- The *gall bladder* in Ox is a pear-shaped sac 4 to 6 inches long, which lies partly on the visceral surface and largely in contact with the abdominal wall at the ventral part of the 10th or 11th intercostal space
- Its neck is continued by the cystic duct, which joins the hepatic duct to form the common bile duct - ductus choledochus, which opens into the ventral part of the S-shaped curve of the duodenum

LIVER (SHEEP AND GOAT)

- The liver weighs 550-700 gm
- It lies entirely to the right of the plane. The parietal surface is related to the right of the diaphragm exclusively
- The visceral surface presents extensive reticular and abomasal impressions and a small omasal impression medial to the portal fissure
- The umbilical fissure is deep and partially divides the gland into two chief lobes, dorsal and ventral
- The caudal lobe is prismatic and blunt pointed
- The esophageal notch is represented by a slight impression. The gall bladder is narrow and long
- The bile duct joins the pancreatic duct to form a common bile duct, which opens into the duodenum about one foot from the pylorus

LIVER (HORSE)

- It is more extensive but thinner. It extends from the right para chondria through the epigastric to the left para chondriac region in a sloping direction from right to left
- Its average weight is about 5 kg. It has three lobes, right; middle or central and a left lobe, separated by inter lobar fissures ventrally
- The right lobe is larger and presents at its upper part the caudate lobe and caudate process. The middle lobe is smaller than the right in the young
- The parietal surface is convex and presents a median vertical fissure -the *fossa vena cava*
- The visceral surface is concave and presents the portal fissure above its middle
- The extensive concave area in front is the gastric impression and behind the portal fissure is the narrow duodenal impression and behind this is the colic impression left by the diaphragmatic flexure of the great colon



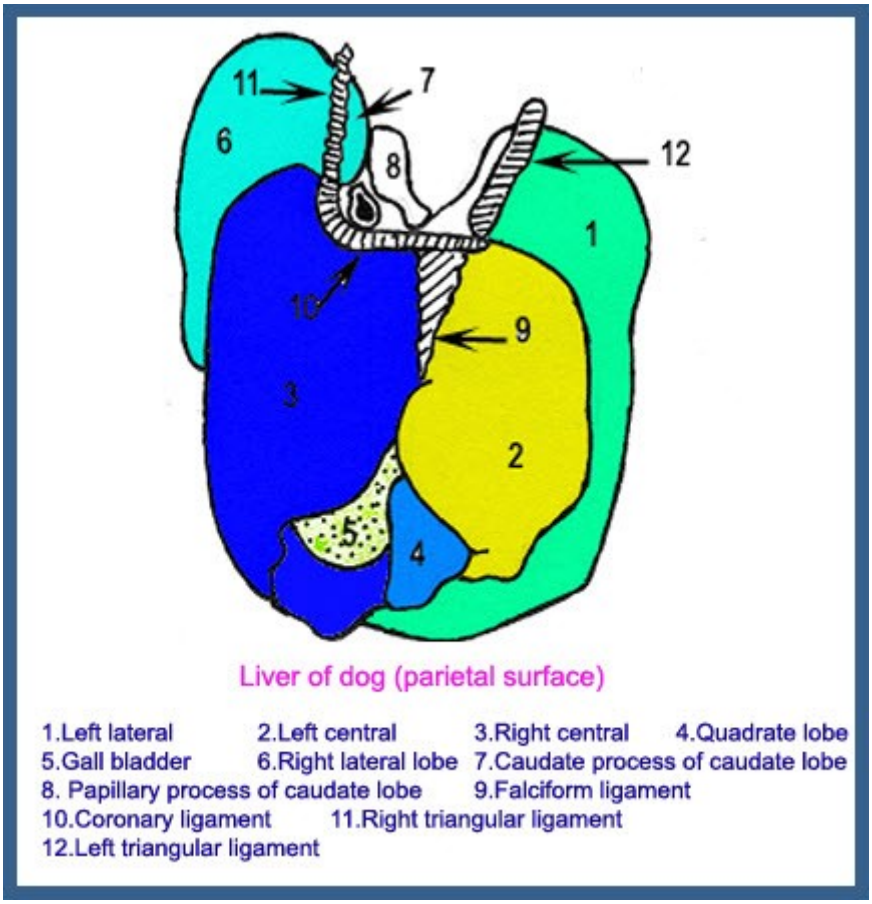
- The visceral surface is concave and presents the portal fissure above its middleThe extensive concave area in front is the gastric impression and behind the portal fissure is the narrow duodenal impression and behind this is the colic impression left by the diaphragmatic flexure of the great colon
- The liver has *no gall bladder*
- The right border is thin. The left border is convex and begins at the oesophageal notch
- The ventral border presents two fissures dividing the liver into three main lobes
- The middle lobe is divided by secondary fissures in to smaller lobes
- The border presents the following from right to left,
    - attachment of right lateral ligament
    - renal impression
    - Fossa vena cava
    - Oesophageal notch
    - attachment of left lateral ligament
    - In addition to the ligaments in the ox there are
        - One left lateral ligament attaching the left lobe to tendinous centre of the diaphragm and
        - One coronary ligaments on either side of the caudal vena cava, which unites below to form the falciform ligament
- The hepatic duct opens into the duodenum about 12 to 15 cm from the pylorus

LIVER (PIG)

- Relatively large
- It is divided into five lobes, viz., right lateral, right central, left central and left lateral, which is the largest lobe and a small caudate lobe
- The gall bladder is placed in a depression on the right central lobe
- The diaphragmatic surface is highly convex

- On the upper part of the right lateral lobe is the caudate lobe. No renal impression exists, as the right kidney does not touch the liver
- The cystic duct joins the hepatic duct at an acute angle
- The bile duct opens at the papilla duodeni about one or two inches from the pylorus

LIVER (DOG)



Liver of dog (parietal surface)

1.Left lateral 2.Left central 3.Right central 4.Quadrate lobe
5.Gall bladder 6.Right lateral lobe 7.Caudate process of caudate lobe
8. Papillary process of caudate lobe 9.Falciform ligament
10.Coronary ligament 11.Right triangular ligament
12.Left triangular ligament

- It weighs about 3% of the body weight
- It consists of five lobes -Rt. Lateral, Central, Caudate, Lt-central and Lt-lateral divided by fissures, which converge towards the portal fissure
    - The left lateral lobe is largest and is oval
    - The left central lobe is prismatic
    - The right central lobe is second in size and presents a tongue-shaped quadrate lobe divided from it by a deep fissure in which the gall bladder is lodged
    - The right lateral is third in size and is oval. On its visceral face is the
    - Caudate lobe made up of a caudate process on the right and a papillary process on the left
- The parietal surface is convex and is related to the diaphragm and the adjacent part of the inferior wall of abdomen
- The visceral surface is concave and presents the large gastric impression on the left lateral lobe
- The portal fissure is between the papillary and caudate lobes
- The dorsal border presents a deep renal impression for the right kidney on the caudate lobe and medial to it, the caudal vena cava passes in a deep groove then continues on the parietal face of right lateral and central lobes. Next to the caudal vena cava, the dorsal border presents a large oesophageal notch
- The ventral border lies on the floor of abdomen at a variable distance behind the xiphoid cartilage
- The gall bladder lies between the two parts of the right central lobe

LIVER (RABBIT)

- It is extensive and comprises of 5 lobes
- Gall bladder is situated in a depression at the visceral surface of the right central lobe
- Diaphragmatic surface is convex
- The renal impression at the right lateral lobe is wide and deep
- Parietal surface is convex and applied against diaphragm and the visceral surface is concave which partially accommodates the stomach

LIVER (FOWL)

- The liver lies in the ventral part of the body cavity
- Its parietal surface is convex and is related to the ventral and lateral walls of abdomen
- It presents a deep cardiac impression in front for the pericardium and heart
- The visceral surface is irregular and concave. It presents impression left by the proventriculus and gizzard while on the right is impressions from the spleen and small intestine
- The gall bladder is situated on the right caudal part of this face
- The gland consists of 2 lobes, of which the right is larger
- The hepato-cystic duct extends from the right lobe to the gall bladder from where a ductus cysticus passes to the termination of the duodenum
- Close to it's opening is the orifice of the hepato-enteric duct from the left lobe

PANCREAS

- Abdominal salivary gland

PANCREAS (OX, SHEEP AND GOAT)

Ox

- It is commonly known as *sweetbread or abdominal salivary gland*
- The pancreas is a racemose gland mostly at the right of the median plane and it is attached to the visceral surface of the liver by the mesentery
- When fresh it is reddish cream in colour and resembles salivary gland in appearance. It weighs about 350 gm. and is irregularly quadrilateral in outline
- It presents two surfaces, four borders and four angles. The dorsal surface is attached to the liver and diaphragm and mostly covered by peritoneum
- The dorsal surface is related to the liver, ventral face of right kidney and right adrenal, coeliac, cranial mesenteric artery
- The right side is much larger than the left side and extends backwards beyond the liver to be included in the mesoduodenum and is in contact with the upper part of the flank at lumbo-costal angle. Between these attachments it is free and forms the ventral wall of epiploic foramen
- The *ventral surface* faces downward and is normally in contact with the dorsal curvature of rumen and the intestine.
- The ri*ght border* is longest of the 4 borders and nearly straight and is related to the second part of duodenum
- The *left border* is short, concave and related to the rumen and splenic vessels
- The *cranial border* is also nearly straight, shorter than the right and is situated across the liver at the level of the portal fissure. The *caudal border* is irregular, and presents a deep notch through which the portal vein passes obliquely to the portal fissure of the liver.
- The *duodenal or antero-lateral angle* is at the level where the duodenum forms a 'S' shaped bend

- The *postero-lateral angle* is near the iliac flexure of the duodenum and from this angle the pancreatic duct leaves the gland and opens into the duodenum close to the iliac flexure
- The *antero-medial angle* is at the level where the splenic vessels pass between it and the liver
- The *postero-medial* angle forms the left extremity of the gland and is related to the rumen
- There is only one pancreatic duct, which leaves the gland at the postero-lateral angle

Sheep and Goat

- It is arranged as in ox. Its duct unites with the bile duct

PANCREAS (HORSE)

- The gland is triangular in outline with the apex cranial
- It weighs about 350 gm
- The dorsal surface is related to the liver, right kidney, caudal vena cava and portal vein
- The ventral face is related to the caecum, great colon and small colon. The *right border* is related to the second part of duodenum
- The *left border* is related to the first part of duodenum and left end of stomach. The *caudal border* is notched for the caudal vena cava
- The *cranial or duodenal angle* is attached to the concavity of the second curve of duodenum and the ducts leave the gland at this level
- The *left or splenic angle* fits into the space between the saccus caecus of stomach in front, left kidney behind, spleen dorsally and great colon ventrally
- The *right angle* is rounded and lies at the ventral face of the right kidney
- There are 2 ducts -*major and minor*. The *major duct* opens along with the bile duct in the diverticulum duodeni about 15 cm from the pylorus
- The *minor duct* opens into the duodenum on a papilla opposite to the opening of the chief duct

PANCREAS (PIG)

- It is triangular in outline
- The left lobe is related to stomach and the right lobe is attached to the duodenum
- The parenchyma contains large quantity of fat
- The duct passes from the right extremity directly through the duodenal wall, opening about 4 or 5 inches from the pylorus

PANCREAS (DOG, RABBIT AND FOWL)

Dog

- The pancreas is V shaped consisting of two branches - *right and left,* meeting at an acute angle behind pylorus
- The *right branch* extends backwards above the first part of the duodenum and ends a short distance behind the right kidney
- The *left branch* passes to the left and backwards between the stomach and transverse colon and ends at the cranial pole of the left kidney
- There are two ducts. The major duct opens separately into the duodenum behind the opening of the bile duct. The minor duct unites with the bile duct

Rabbit

- It is diffuse and delicate gland in this animal
- The gland is situated in the fold of mesentery passing across the loops of duodenum. The duct is single

Fowl

- The pancreas is long narrow lobulated yellowish red gland, which is situated in the loop formed between the two parts of duodenum
- Two or three ducts open into the duodenum close to the opening of the bile ducts

MODULE-10: RESPIRATORY SYSTEM

Learning objectives

- To know about site of auscultation and different parts of respirtory system i.e. larynx to alveoli
- To know about the peculiarity of respiratory system of fowl

NASAL CAVITY (OX)

- The nasal cavity is the first section of the respiratory tract. It is a short tubular passage, wide in front and narrow behind, enclosed by the facial bones
- It is separated from the mouth by the palate and opens in front at the cranial nares or nostrils and caudally it opens into the pharynx through *the caudal nares*.
- The *nostrils (nares)* are two-left and right and are somewhat oval in outline and are placed obliquely so that they are closer together below than above
- They are situated at either end of the muzzle. They are bounded by two alae or wing and cranial part of the cartilaginous septum.
- The alae meet above and below forming commissures
- The superior commissure is narrow and the inferior one is wide and rounded
- The lateral alae are concave and medial one is convex above and concave below. The prominence of the medial alae is caused by the lamina of the alar cartilage
- The alar cartilage forms the dorsal wall by its lamina and the lateral wall by its cornua and a transverse bar looks like an anchor
- The medial wall is formed by the nasal septum.
- The skin on the dorsal and lateral wall is covered by hairs and the skin between and around the lining of the nostrils is devoid of hairs and is smooth, bare and moist
- There is no clear line of demarcation between the skin and nasal mucosa.
- The *nasal cavity* is short wide cranially and narrow behind. The nasal cavity is divided into two halves by an osseo-cartilaginous septum nasi
- The osseous part is formed by the perpendicular plate of the ethmoid, vomer and the cartilaginous part by the septal cartilage
- The surfaces of the cartilage form the internal walls of the nasal cavity
- The dorsal border is attached along the frontal and nasal sutures and extends beyond the apices of the nasal bones about two inches
- The nasal cavity is not completely divided by the septum nasi due to the fact that the caudal third of septum nasi is separated from the floor of the nasal cavity by an interval that increases from before backward
- The cavity is mostly occupied by the nasal and ethmo-turbinates
- It is divided into three passages or meatuses called as *dorsal, middle and ventral nasal meatus*.

(Click to peep inside the nasal cavity)

- The *dorsal nasal meatus* is a narrow passage between the roof of the nasal cavity and the dorsal turbinate bone
- Its caudal end is closed by the junction of the inner plate of the frontal bone with the cribriform plate and lateral mass of the ethmoid. It transmits air to the olfactory region.
- The *middle nasal meatus* is between the dorsal and ventral turbinate bones

- It is a very narrow passage and divides caudally into two branches by the intervention of the ethmoturbinates
- The *ventral nasal meatus* is situated between the ventral turbinate and the floor of the nasal cavity
- It is much larger than the other two and is the direct passage between nostrils and pharynx
- The opening of the vomero-nasal organ and incisive or naso palatine duct is situated in the floor of the cranial end of this meatus
- The *common nasal meatus* is situated between the nasal septum and the turbinates and is continuous laterally with the other meatuses. It is narrow dorsally but wider ventrally.
- The *caudal nares or chonae* are elliptical openings by which the nasal cavity and the pharynx communicate and situated in the same plane on the floor of the nasal cavity at its caudal extremity and are separated by the vomer.
- The nasal cavity is lined by mucous membrane, which is highly vascular
- In front, it is continuous with the skin lining the nostrils and behind with the mucous membrane of the pharynx
- The lower three-fourth of the mucous membrane is red in colour and forms the respiratory portion
- The upper fourth paler part forms the olfactory portion, which is responsible for smell.
- The *ductus incisivus (naso-palatine duct)* is a small mucous tube, which extends from the nasal cavity to the papilla incisive
- The nasal opening of this duct opens on the medial surface of the alar fold of the ventral nasal meatus

ORGAN OF JACOBSON

- The *vomero-nasal organ (organ of Jacobson)* is a cartilaginous tube situated on the floor of the nasal cavity on either side of the ventral border of the septum nasi in its cranial third
- They open on the oral cavity on either side of the papilla incisiva along with those of the ductus incisivus. The caudal end is blind

NASAL CAVITY
(Sheep, Goat, Horse, Pig, Dog, Rabbit, Fowl)

Sheep and Goat

- Generally resembles ox with little modifications. The nostrils are nearly horizontal slits
- The ductus incisivus is short

TOP

Horse

- The nasal cavity is longer and cylindrical
- The nostrils are very dilatable and are divided by the alar fold into a small blind diverticulum on the upper part - the *false nostril* and a large lower part - *true nostril*
- The naso-lacrimal orifice is visible on the floor of the true nostril about 2" behind the inferior commissure
- The ductus incisivus is blind at its dorsal end

TOP

Pig

- The nostrils are situated in the flat cranial surface of the *rostrum or snout,* a short cylindrical projection with which the upper lip is fused and is circumscribed by a prominent circular margin
- The nostrils cannot be dilated much because they are embedded within the skeleton of the face
- The nose is extended from the snout to the level of the eye

- In the snout, a bone, *os rostri* between the nostrils is seen as an adaptation to the habit of burrowing or rooting
- The skin covering the snout is pigmented and divided by shallow grooves
- These surface markings are specific for individual animals and helpful in identification
- The nasal cavity is long and narrow
- The incisive duct and vomero-nasal organ are as in ox

TOP

Dog

- The nostrils are comma-shaped (See the Comma-shaped nostril)
- The nasal cavity varies greatly in different breeds
- It is almost completely occupied by the turbinate bones

TOP

Rabbit

- The nostrils are in the form of elongated slits between the nasal flap and the upper jaw
- The nasal bones are well built and the nasal cavities are extended

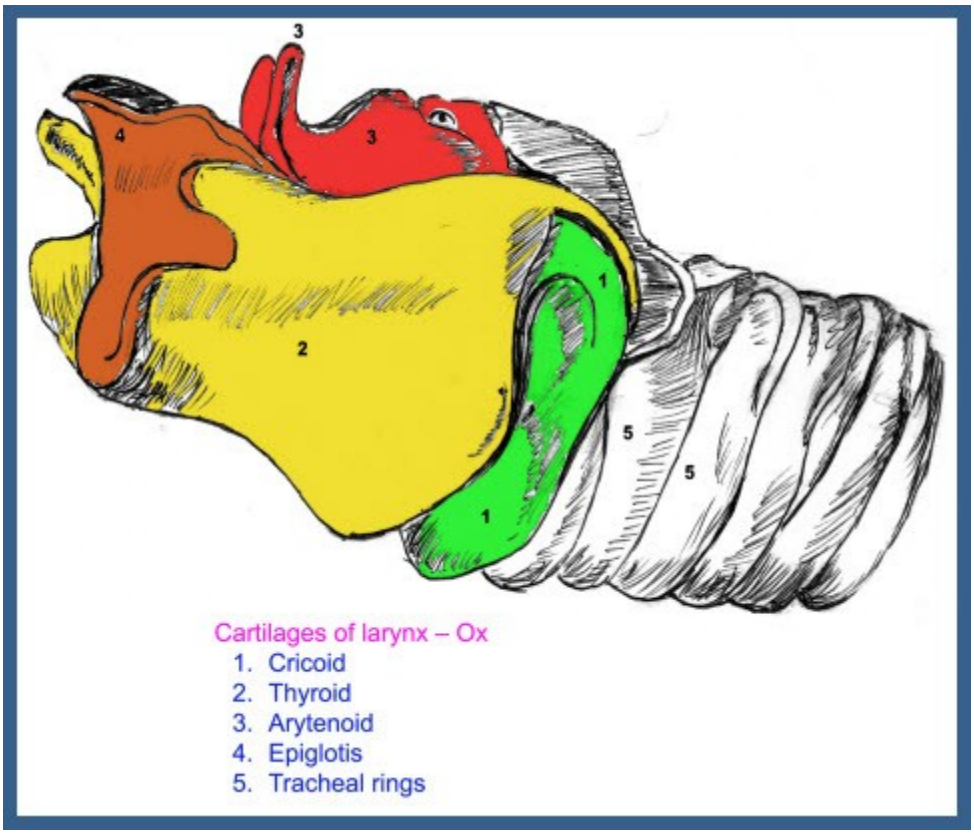
TOP

Fowl

- The nostrils are two narrow oval openings placed at the base of the upper beak and these are cartilaginous
- The cavity opens into the mouth and pharynx by a long narrow slit like opening
- The dorsal border of the nostrils are bounded by a small piece of horny skin-the *operculum*

LARYNX (OX)

- The larynx is a short musculo-cartilaginous tube, which connects the pharynx with the trachea. It is a valvular apparatus, which regulates the amount of air and is the organ of voice



- It is situated partly between the two vertical rami of mandible and medial pterygoid muscles and partly between the two parotid salivary glands
- It is related *dorsally* to pharynx and oesophagus; *Ventrally* to skin, fascia, sternothyrohyoideus and omohyoideus muscles; *Laterally*, to parotid and submaxillary salivary glands and *medially* pterygoid muscle, digastricus and stylohyoideus muscles
- It is attached to the body and thyroid cornua of the hyoid bone and the pharynx
- The cavity communicates above with the pharynx and behind with the trachea
- The larynx is made up of a framework of cartilages connected by ligaments and moved by muscles and is lined internally by mucous membrane
- The cartilages are cricoid, thyroid, arytenoid and epiglottis**.** Of these, the arytenoids are paired, and the others unpaired

CARTILAGES OF LARYNX

Cricoid cartilage

- The cricoid cartilage is a ring shaped cartilage
- It consists of a dorsal part- the lamina and ventral and lateral parts -the arches
- The *lamina* is broad and thick and is marked by a large median ridge
- On either side of this ridge are two facets, the cranial of which articulates with the arytenoids and the caudal with the caudal cornua of thyroid cartilage
- Both the articulations are syndesmoses. The arches are curved and each presents a groove on the lateral surface for the crico-thyroid muscle
- The *cranial border* gives attachment to thyroid cartilage by the cricothyroid membrane while the *caudal border* gives attachment to first ring of trachea by the crico-tracheal membrane
- The internal surface is lined by mucous membrane

Thyroid cartilage

- The thyroid cartilage is a shield-shaped cartilage
- It consists of a central part, the body and two lateral parts- the laminae
- The *body* is attached to the base of the epiglottis by the thyro-epiglottic ligament
- The body shows a prominence ventrally, the laryngeal prominence
- The laminae form the sides of larynx and unite completely on the ventral aspect to form a long plate, which is notched in front, and behind
- It presents two cornua on either side: the *cranial* and *caudal cornua*
- The *cranial cornua* articulates with the thyroid cornua of the hyoid bone by syndesmoses and the *caudal cornu* with the facet on the caudal part of the lamina of the cricoid cartilage again by syndesmoses
- The cranial cornua presents below its upper border a thyroid notch or foramen for the passage of the cranial laryngeal nerve

Arytenoid cartilages

- The arytenoid cartilages are paired and each is situated dorsally, in front of the cricoid, partly medial and dorsal to the lamina of the thyroid cartilage
- It is pyramidal in form and presents three surfaces (*medial, dorsal and lateral*) three borders (*cranial, caudal and lateral*), a *base* and an *apex*
- The *base* faces backward and articulates with cricoid. The *apex* is in front and curves upwards and backwards
- The *cranial* and *caudal borders* converge ventrally to form the vocal process. The process is so named because it furnishes attachment to vocal ligament
- The medial angle of the base is attached to its fellow by a transverse arytenoid ligament

Epiglottis

- The epiglottis is short, leaf-like plate of cartilage placed above the body of the thyroid. It presents *two surfaces, two borders,* a *base* and an *apex*
- The surfaces are *oral* and *pharyngeal surface*. The borders are thin, irregular and somewhat everted. The *base* is caudal, attached to the thyroid cartilage
- The *apex* is cranial and the *tip* is free rounded and curves towards the root of the tongue. The surfaces are lined by mucous membrane.
- The cricoid and thyroid cartilages and the greater part of the arytenoid cartilages are hyaline in nature
- The apices, vocal processes of the arytenoid and the epiglottis consist of elastic cartilage. They show no tendency towards ossification at any age

JOINTS, LIGAMENTS AND MEMBRANES OF LARYNX

- The joints formed by the cartilages of the larynx are,
    - *Cricothyroid* between the cricoid and caudal cornu of the thyroid (syndesmoses)
    - *Crico-arytenoid* between the cricoid and bases of the arytenoid (syndesmoses)
    - *Thyro - hyoid* between the cranial cornu of the thyroid and thyroid cornu of the hyoid bone (syndesmoses)
- The chief ligaments are,
    - *Hyo-epiglottic* which attaches the lower part of the oral surface of the epiglottis to the body of the hyoid bone
    - *Thyro - epiglottic* which connects the base of the epiglottis with the body and adjacent medial surfaces of the laminae of thyroid
    - The *transverse arytenoid* which connects the medial angles of the bases of the arytenoid
    - The *vocal ligament* (caudal thyro-arytenoid) underlies and is intimately adherent to the mucous membrane of the vocal fold
    - It is attached to the vocal process of the arytenoid and the body of the thyroid
    - The *ventricular* (cranial thyro-arytenoid) ligament is included in the ventricular fold
    - It passes from the thyro- epiglottic ligament to the vocal process of the arytenoid. It is poorly developed

- The chief membranes of the larynx are,
    - The *cricothyroid* between the arch of the cricoid and the body of the thyroid
    - *Thyro - hyoid* membrane between the cranial border of the thyroid cartilage and thyroid cornua of the hyoid bone
    - *Crico - tracheal* membrane connects the cricoid and first ring of the trachea

CAVITY OF LARYNX

- The *cavity of the larynx* is much smaller than one would naturally expect, from its external appearance. On looking into it through the pharyngeal end, narrow folds are seen, projecting from each lateral wall. These are the *vocal folds*
- The narrow part of the cavity between the vocal folds is the *rima glottidis*
- The cavity consists of three parts - the *auditus laryngis, vestibule and the caudal compartment*
- The *auditus laryngis or pharyngeal aperture* is a large, oblique, oval opening which faces into the ventral part of the pharynx
- It is bounded in front by the epiglottis above and behind by arytenoid cartilages and laterally by the aryepiglottic folds of mucous membrane, which stretch between the edges of the epiglottis and arytenoid cartilages.
- The *vestibule* of the larynx extends from the auditus laryngius to the vocal folds
- On its lateral walls are the very faint elevations covering the ventricular ligament and called the *ventricular folds or false vocal cords*
- Between the ventricular and vocal folds on each side is a very faint depression corresponding to the lateral ventricle of the horse
- The middle narrow part of the cavity is termed the glottis or rima glottis
- It is bounded on either side by the vocal folds and the medial faces of the arytenoid cartilages
- The *vocal folds or true vocal cords* are the fold of mucous membrane projecting from the lateral wall of the cavity of the larynx and are responsible for the production of voice
- The vocal folds covering the vocal ligaments. In ordinary breathing, the rima is lanceolate in form; when dilated, it is diamond shaped
- The widest part being between the vocal processes. The narrow part of the glottis between the vocal cords is termed the *pars intermembranaecea*, while the wider part between the arytenoid cartilages is the pars *intercartilaginea*.
- The *caudal compartment* of the laryngeal cavity is directly continuous with the trachea
- It is enclosed by the cricoid cartilage and the cricothyroid membrane. It is oval in form.
- The mucous membrane of the larynx is reflected around the margin of the auditus and become continuous with that of pharynx and is continuous behind with that which lines the trachea

LARYNX
(Sheep, Goat, Horse, Pig, Dog, Rabbit and Fowl)

Sheep and Goat

- Resembles Ox

Horse (View image)

- Cricoid is clearly ring shaped
- Thyroid cartilage is incomplete ventrally, as the lamina fails to meet below to form the body
- The epiglottis is long and pointed, and is leaf-like
- Two *cuneiform processes* extend from the base of the epiglottis upwards and backwards
- The different joints of the larynx are diarthrodial
- The vocal cords are large and glottis is very narrow
- The ventricular folds are more prominent
- The lateral ventricles are much deeper and each leads into a mucous sac–the laryngeal saccule
- The base of the epiglottis shows a small middle ventricle between the lower ends of the vocal folds

TOP

Pig

- The larynx is remarkable for its great length and mobility
- The cartilages are more loosely attached to each other than in old animals
- Cricoid is thick and compressed laterally. Its lamina is long and narrow
- Thyroid cartilage is very long and the laminae are united ventrally to form a median ridge
- The cranial cornua are absent whereas the caudal one is broad and articulate with cricoid cartilage
- Epiglottis is relatively large and closely attached to hyoid bone than the rest of the larynx
- Arytenoids are very large and are divided into two parts at its extremity
- A median laryngeal recess is present in the floor of the vestibule
- The vestibular folds are absent
- The caudal part of the vocal ligament and the thyroarytenoideus form the bulk of the vocal fold

TOP

Dog (View image)

- It is very short
- Cricoid is wider above
- The epiglottis is quadrilateral
- The separate cuneiform cartilages are large
- The *laryngeal saccule* is extensive and lies lateral to both true and false vocal cords

TOP

Rabbit

- The thyroid cartilage forms the greater portion of the larynx
- Cricoid cartilage is small and cylindrical
- A pair of small arytenoid cartilage is at the margin of the glottis
- The epiglottis projects dorsally into the pharynx. The tip of the epiglottis is rounded but bifurcated

TOP

Fowl

- The larynx consists of *cranial* and *caudal* parts
- The *cranial part* of larynx made up of cricoid-epiglottis
- The *caudal part* is at the point of bifurcation of trachea into two primary bronchi and dilated to form a cartilaginous compartment called *syrinx*
- It is responsible for the production of voice. The membranes present inside the organ produce the voice
- Between the bronchial openings is a ridge, the *carnia* and this presents on each side an elastic membrane the internal tympani form membrane
- These together with two other folds the external tympani form membranes on the bronchi, produce slit-like bronchial openings comparable to the glottis of mammals
- Tympani form membranes are homologues of the vocal cords of mammals
- The framework is made up of cricoid and two arytenoids that unite in front
- It has no vocal cords and hence is not an organ of voice

TRACHEA (OX)

- The trachea is a flexible cartilaginous tube extending from the larynx to the hilus of the lungs where it divides into right and left bronchi
- It is kept permanently open by a series of about 50 'C' shaped cartilaginous rings embedded in its walls
- It occupies a median position except at is termination where it is pushed a little to the right of the median plane by the aortic arch
- Its average length is about 65 cm, the width about 4 cm and height 5 cm
- It is approximately cylindrical but its cervical part is for the most part compressed from above downwards whereas at its origin it is almost circular
- The trachea has *cervical and thoracic* parts
- The *cervical part* is related *dorsally* to the oesophagus for a short distance and for the rest of its extent to the longus colli muscles
- *Laterally* it is related to the lateral lobes of the thyroid gland, carotid artery, vagus, sympathetic and recurrent laryngeal nerves, tracheal lymph ducts and cervical lymph glands
- The oesophagus lies on its left from the third cervical vertebra backwards. *Ventrally* it is related to the ventral cervical muscles
- The sternocephalicus muscle crosses it obliquely, passing from the ventral surface forwards on its sides to reach the angles of the jaw
- The omohyoideus crosses it very obliquely, passing over the lateral surface of the cervical part of the trachea in its upper third
- The sternothyrohyoideus covers the ventral aspect of the trachea. The scalenus lie on either side near the entrance to the thorax
- This arrangement of the muscles leaves a small area of the ventral face of the trachea at its upper third covered only by the skin
- The *thoracic part* of the trachea passes backward between the two pleural sacs and divides into two bronchi opposite to the 5 th rib
- It is related dorsally to the oesophagus and longus colli muscle. Its *left face* is related to the aortic arch, left brachial artery and thoracic duct
- Its *right face* is crossed by the right vagus. *Ventrally,* the trachea is related to the cranial vena cava, brachio-cephalic trunk, cardiac and recurrent laryngeal nerves
- The trachea in the ox detaches a small apical bronchus to the apical lobe of right lung about the level of the third rib or intercostal space and beyond this it is adherent to the right lung

Structure

- The trachea is composed of cartilaginous rings
- The free ends of rings are separated by an interval and are C-shaped, in the cervical part
- The deficiency above is made up by the fibro-elastic membrane - *membrana transversa,* which encloses the tracheal rings and the trachealis muscle
- The adjacent cartilages are united by the *tracheal annular ligaments*
- In the thoracic part the two edges of the rings meet and form the ridge
- The mucous membrane is lined by ciliated epithelium.

TRACHEA

Species Difference

Sheep and Goat

- The average length of the trachea is about nine or ten inches and its caliber is little less than an inch
- In the sheep, the ends of the tracheal cartilages overlap in the cranial third of the trachea and in the caudal third, the left ends of the tracheal cartilages extend further dorsally than the right ends
- The trachea of the goat is U shaped on cross section with variable distance between the right and left ends of the cartilages

Horse

- It is longest; about 75 to 80 cm. Caliber is 5 to 6 cm
- The free ends of the rings overlap in the cervical part while they do not meet in the dorsal part
- It does not give any additional bronchus to the right lung and is not adherent to the lungs

Pig

- Consists of 32-35 rings, which overlap dorsally
- Occasionally, adjacent cartilages become partly or completely fused
- A special apical bronchus is detached for the apical lobe of the right lung

Dog

- It contains about 40 to 45 rings, which are C-shaped, and their ends do not meet dorsally
- Trachealis muscle is attached to the outside of the cartilages

Rabbit

- The trachea is about 6cm long and possesses no apical bronchus

Fowl

- The cartilage rings are complete
- The trachea connects the cranial larynx and syrinx or caudal larynx

BRONCHI

Ox

- The two bronchi are the terminal branches of the trachea. They are right and left
- The right is shorter than the left. Each passes outwards and backwards and enters the hilus of the corresponding lung and branches like a tree within the lung substance and terminates in air sacs. There is an additional bronchus -the apical bronchus to the apical lobe of the right lung detached about the level of the 3rd rib
- Each bronchus is related above to the branches of the bronchial artery and bronchial lymph glands and below to the divisions of pulmonary artery and vein
- The structure is the same as that of the trachea except that the plates of cartilage replace the cartilaginous rings

Species difference

Sheep and Goat

- It resembles ox

Horse

- There are only two chief bronchi

Pig

- As in ox.
- The apical bronchus to the apical lobe of the right lung detached about the level of the third rib

Dog

- Each bronchus divides into two branches before it enters the hilus of the lung

Rabbit

- There are two chief bronchi, right and left

Fowl

- There are two chief bronchi

LUNGS (OX)

Ox

- The lungs, the essential organs of respiration are *right and left* and each occupy the greater part of the thoracic cavity
- They are accurately adapted to the walls of the cavity and the other organs contained in it. Each lung is soft, spongy and highly elastic
- It crepitates when pressed and floats in water
- The colour varies according to the amount of blood contained in the lung. During life, it is pink in colour
- In dissected bodies, it is light grey in colour and slightly tinged with red. The average weight of lungs is 3.4 kg
- The right lung weighs about half as much as the left one
- The fetal lung presents the following characters,
    - It is much smaller
    - It is firmer and does not crepitate
    - It is pale grey in colour
    - It sinks in water
- In form, the lungs are like the casts of the cavities in which they are situated
- When well hardened in situ, their surfaces present impressions and elevations corresponding exactly to the structures with which they are in contact
- The right lung is larger than the left.
- Each lung presents for description two surfaces, two borders, a base and an apex. The costal surface is convex and lies against the lateral wall of the thorax, it presents impressions of the ribs
- The mediastinal surface is less extensive and molded on the mediastinum and its contents
- It presents a little in front of it middle, an irregular depression -the hilus of the lung where the structure, which compose the root of lung, enter or leave the organ
- In front of the root, each lung presents a large cavity adapted to the heart -the *cardiac impression*. Behind the hilus and slightly above it are two grooves -a dorsal one for the aorta and a ventral for the oesophagus.
- The dorsal border is long, thick and rounded. The ventral border is thin and presents two deep fissures, which divide the lungs into a variable number of lobes
- The left lung presents a large quadrilateral cardiac notch extending from the ventral end of the third intercostal space to the fourth intercostal space and here the pericardium and heart are in contact with the chest wall. Behind this notch there is a fissure
- The fissure and notch divide the left lung into three lobes - the one in front of the cardiac notch is the *apical lobe,* and behind it is the cardiac lobe and behind the fissure is the *diaphragmatic lobe*. On the right lung, there are two fissures on the ventral border dividing it into *apical, cardiac and diaphragmatic lobes*
- The apical lobe is divided into two parts by a deep fissure
- The apical lobe of the right lung is much larger than that of the left lung and occupies the space in front of the pericardium, pushing the mediastinum against the left wall
- The apical lobe of the right lung receives a special bronchus from the trachea opposite the third rib or space and is adherent to the trachea from here backward
- The mediastinal face presents a small *mediastinal or intermediate lobe.*
- The base of the lung is oval in outline; its surface (*diaphragmatic surface*) is deeply concave, in adaptation to the thoracic surface of the diaphragm

- Laterally and dorsally it is limited by a thin convex basal border, which fits into the narrow recess between the diaphragm and lateral chest wall.
- The apex of the lung is prismatic, narrow and flattened transversely. It curves downward, and is related deeply to the cranial mediastinum and to the cranial part of the pericardium.
- The root of the lung is composed of the structures, which enter or leave the lung at the hilus on the mediastinal surface. These are
    - The bronchus
    - The pulmonary artery
    - The pulmonary veins
    - The bronchial artery
    - The pulmonary nerves and
    - The pulmonary lymph vessels
- The bronchus is situated dorsally with the bronchial artery on its upper surface and the pulmonary artery immediately below it
- The pulmonary veins lie chiefly below and behind the artery

Bronchi

- Each bronchus enters the hilus of the lung
- The left bronchus first gives off a branch, which supplies both the apical and cardiac lobes and is then continued as the stem bronchus to the diaphragmatic lobe
- The right bronchus gives off a branch, which supplies the cardiac lobe and is continued as the stem bronchus to the diaphragmatic lobe
- A branch is detached from the medial face of the stem bronchus to the mediastinal lobe
- The apical bronchus from the trachea supplies the apical lobe. The lobulation of lung is very evident on account of abundant interlobular tissue

LUNGS
(Sheep, Goat, Horse, Pig, Dog, Rabbit, Fowl)

Sheep and Goat

- It resembles those of ox but differ from them in shape. There is a cardiac notch
- Lobulation is much less distinct than in the ox

TOP

Horse

- The lungs of the horse are not divided by deep fissures, as in case of most mammals
- The left lung consists of a chief part -the body and an apex. In addition to these, the right lung has an intermediate lobe
- The lobulation of the lung is not very evident on account of the small amount of interlobular tissue
- The trachea is not adherent to the lung
- The cardiac notch is larger in the right lung than the left
- Behind the root of the lung, the two lungs are adherent to each other on the triangular area. Behind the area of adhesion the mediastinal pleura forms a fold called the *pulmonary ligament (ligament of lung)*

TOP

Pig

- The right lung has four lobes- apical, cardiac, diaphragmatic and intermediate
- In some cases, apical lobe is divided into two parts. Sometimes it is fused with cardiac lobe

- Lobulation is distinct
- The apical bronchus is present for the right apical lobe at the level of 3 rd rib

TOP

Dog

- The costal surface of lungs is convex
- Lobulation is not distinct
- Interlobular fissures are deep and extend to the root
- The right lung has four lobes and left has three
- The cardiac notch is larger on the right side than on the left

TOP

Rabbit

- Right lung has 4 distinct lobes- apical, cardiac, diaphragmatic and intermediate lobes
- The left lung has only two lobes; apico-cardio and diaphragmatic lobes

TOP

Fowl

- They are small and occupy the dorsal part of the thorax. They are intimately adherent to the ribs and the costal impressions are deeper
- The stem bronchus enters the ventral surface of the lung about its middle. It continues backwards through the lungs and opens into the abdominal air sacs
- Within the lungs, the stem bronchus gives off secondary bronchi, which enter the cervical, clavicular and thoracic air sacs
- Numerous tertiary bronchi radiate towards the periphery

AIR SACS OF FOWL

- The *air sacs* are thin walled sacs lined with mucous membrane and covered by serous membrane
- They all form a means of communication between a bronchus and the interior of some of the pneumatic bones
- There are eleven sacs, *cervical, clavicular, axillary, cranial thoracic, caudal thoracic and abdominal*. All are paired except the clavicular, which is single
- The thoracic air sac does not communicate with pneumatic bones
- The primary function of the air sacs is to compensate for the small total capacity of the bird's lung with the aid of respiratory muscles, they act as bellows to ventilate the lung in such a manner that a continuous stream of air passes through the air capillaries both during inspiration and expiration
- This function carried out mainly by caudal thoracic and abdominal air sacs. All the air sacs together contribute to the reduction of the specific gravity of the avian body
- It is playing vital role in the regulation of the body temperature
- It also helps in even distribution of the body weight during the flight and in voice production

MODULE-11: URINARY SYSTEM

Learning objectives

- To know about the water filters of the body i.e. kidney and its assistants

- To know about the location and toography of urinary system

KIDNEY

- The urinary organs are the *kidneys, ureters, bladder and urethra*
- The kidneys are glands that secrete the urine
- The ureters are tubes, which convey the urine to the urinary bladder
- The urinary bladder is a reservoir for the urine
- The urine accumulates in the bladder and is then expelled through the urethra

KIDNEY (OX)

- The kidneys are two compound tubular glands in the sublumbar region. They are elongated and elliptical in outline
- It is reddish brown in colour and their surface is marked by numerous fissures dividing them into polygonal lobes about 20 in number
- The fissures are filled with fat. Each weighs about 600 to 700 gm The left one being usually 30 gm. or so heavier
- They are embedded in a large amount of fat. The right kidney measures about 20 to 22.5 cm long, 10 to 12 cm wide 5 to 6 cm thick
- The left one is slightly shorter but thicker

RIGHT KIDNEY (OX)

- The *right kidney* presents two surfaces, two borders and two extremities
- It is situated ventral to the last rib and the first two or three lumbar transverse processes but its extremities may be ventral to the 1^{st} and 4^{th} lumbar transverse process
- The *dorsal surface* is rounded and is in contact with the sublumbar muscles. The *ventral surface* is less convex and related to the liver, pancreas, duodenum and colon
- The hilus is an extensive, elliptical cavity situated at the *cranial part of the ventral surface near the medial border*
- The *medial border* is nearly straight and lies parallel to the caudal venacava. The *lateral border* is convex
- The *cranial extremity* is thick, lies in the renal impression of the liver and is related to the adrenal. The *caudal extremity* is narrow and pointed
- The right kidney is more firmly attached than the left because of its attachment to the liver by caudate ligament

LEFT KIDNEY (OX)

- The left kidney is variable in position. When the rumen is full, it pushes the kidney backward and across the median plane, so that it is situated on the right side behind and at a lower level than the right kidney
- It lies below the bodies of the third, fourth and fifth lumbar vertebrae
- When the rumen is not so full, it is slightly towards the left. It presents three surfaces
- The dorsal surface in convex and is related to the bodies of the lumbar vertebrae and sublumbar muscles
- The ventral surface is less convex and is related to the intestine
- The lateral surface is flattened due to its contact with the rumen and is hence termed the ruminal surface
- The medial border is nearly straight and is related to the abdominal aorta and ureter
- The hilus is a deep fissure and situated on the antero-lateral aspect of the dorsal

surface of the left kidney

Last modified: Tuesday, 31 July 2012, 12:44 PM

CORTEX AND MEDULLA - KIDNEY

- The cortex presents a granular appearance and is studded with numerous minute dark points, the renal or Malphigian corpuscles
- It consists of dilated origins of the renal tubules, the Bowman's capsule which encloses a tuft of capillaries, the glomerulus
- The medulla is pale and presents at its junction with the cortex an intermediate vascular zone
- The medulla consists of uriniferous tubules, blood vessels and lymphatics connected together by connective tissue
- The straight portions of the tubules appear as conical masses called - renal pyramids (20 in number with their bases directed towards the cortex)
- Between the pyramids a part of the cortex dips inwards forming the renal columns of Bertini
- They present at the apex, the renal-papilla, which is enclosed or embraced by the funnel-shaped end of a tube -the calyx minor, which opens into a larger calyx major
- Two such calyces major from the two extremities unite at the hilus to form the excretory duct, the ureter. The renal pelvis is absent

Last modified: Tuesday, 31 July 2012, 12:45 PM

KIDNEY
(Sheep, Goat, Horse, Pig, Dog, Rabbit, Fowl)

Sheep and Goat

- The kidneys are bean shaped and smooth
- In position, they resemble ox except that the right one is usually a little further back and lies under the first three lumbar transverse process
- The hilus is present at the middle of the medial border
- They are similar to each other and very much close to the dog and very difficult to distinguish them
- They are more regular in shape than dogs, being protected from the distorting pressures by thick masses of fat
- The fat cushion makes the left kidney less subject to the displacement

TOP

Horse

- The surfaces are smooth and are not lobulated. The average weight is about 700 gm
- The right kidney weighs 30 to 60 gm. more than the left. The right kidney is 15 cm long, 15 cm wide and 5 cm wide
- The right is shorter, wider and thicker than the left
- The right kidney resembles the heart of playing cards while the left is bean shaped
- The right is situated under the vertebral end of the last two or three ribs and 1st lumbar transverse process
- The left one is under the last rib and the first two or three lumbar transverse processes
- The hilus is about the middle of the medial border in the form of a deep notch in both kidneys
- The dorsal surface of the right kidney is convex and is related chiefly to the diaphragm whereas the ventral surface is concave and related to the liver, pancreas, caecum and adrenal gland

- The cranial extremity of the right is thicker and rounded, lies in the renal impression of the liver
- The caudal extremity is thinner and narrower
- The caudal extremity of the left kidney is wider and thicker
- The hilus leads into a renal sinus in the interior for the lodgment of the renal pelvis, which is the dilated origin of the ureter
- The inner central part of the medulla forms a concave ridge - the renal crest, which presents numerous openings - the area cribrosa through which the large ducts open into the renal pelvis

TOP

Pig

- Smooth and bean shaped
- It is more elongated
- The right and left kidneys are almost symmetrically placed ventral to the transverse processes of the first four lumbar vertebrae, but the left is often a little further forward than the right one
- The right kidney has no contact with the liver
- The hilus is about the middle of the medial border
- Each kidney possesses two calyces major and about a dozen of calyces minor

TOP

Dog

- The kidneys are smooth and bean shaped. The average weight is 50 to 60 gm
- The right kidney is situated under the bodies of the first three lumbar vertebrae
- The left kidney is about the level of the 2^{nd} , 3^{rd} and 4^{th} lumbar vertebrae but when the stomach is full, it is pushed to one vertebra further back, so that the cranial pole may be placed behind the caudal pole of the right
- The hilus is about the middle of the medial border. The medulla shows a renal crest

TOP

Rabbit

- The kidneys are smooth and bean shaped
- Right kidney is situated below the proximal end of the last rib and first two lumbar transverse processes and the left kidney is placed below the bodies of 2^{nd} and 3^{rd} lumbar vertebrae
- The kidneys are unipyramidal

TOP

Fowl

- The kidneys are brown coloured elongated structures and lie along each side of the vertebral column from the vertebral end of the 6^{th} rib into the iliac fossa
- Each is made up of 3 or 4 lobes as cranial, middle and caudal portions. It is friable in nature
- The lobes are not well defined
- The surfaces are rough due to projected surfaces of the renal tubules

URETER
(Ox,Sheep, Goat, Horse, Pig, Dog, Rabbit, Fowl)

Ox

- The ureters are the excretory ducts of the kidneys and each begins at the junction of the calyces majores and terminates at the bladder
- It is about 6 to 8 mm in diameter. The right ureter emerges out of the hilus of the right kidney from its ventral face, runs inwards, gains the middle of the medial border of the kidney and runs along it
- The left ureter emerges out of the hilus on the antero-lateral aspect of the dorsal face, crosses over this face medially and gains the medial border and runs backwards.
- Each ureter consists of abdominal and pelvic parts
- The abdominal part runs backwards and inwards, the right being related to the lateral face of the caudal vena cava and the left to the aorta
- Then it passes back in the sub-peritoneal tissue on the ventral face of the psoas muscle crosses the external iliac artery and enters the pelvic cavity
- The pelvic part passes backwards and downwards on the lateral wall of pelvic cavity, turns inward and pierces the superior wall of the bladder near the neck
- In the male, the pelvic part enters the genital fold and crosses vas deferens whereas in the female it is situated in the dorsal part of the broad ligament of the uterus

TOP

Species difference

Sheep and goat

- It resembles that of ox

TOP

Horse

- The ureter arises from the renal pelvis

TOP

Pig

- They are at first relatively wide and gradually diminishes in caliber
- Slightly flexuous

TOP

Dog

- It resembles that of the horse

TOP

Rabbit

- They are simple tubes start from the hilus of the kidneys at the middle of the medial border and terminate at the dorsal aspect of the bladder on either side

TOP

Fowl

- The ureter is white in colour. It may be divided into a renal part and a pelvic part.
- The renal part embedded in the ventral surface of the kidney and the pelvic part runs backward in relation to the vas deferens or oviduct
- It opens into the urodeum of the cloaca, internal to the opening of the vas deferens or oviduct

URINARY BLADDER (OX)

- The urinary bladder is a musculo-membranous sac, differs in form, size and position according to the amount of its contents
- When contracted, it is a dense pyriform mass about the size of a fist and lies on the ventral wall of the pelvic cavity at a variable distance behind the pelvic inlet
- When moderately full, it is oval in shape and extends into the abdominal floor. Its capacity is about 3 to 4 litres.
- The bladder has 3 parts-a vertex, a body and neck
- The cranial part or the vertex is a blind end and presents in its middle a rounded *cul-de-sac* called as cicatrix - the vestige of the urachus, which forms a connection between the bladder and the allantois in the fetus
- The middle part or body is rounded and somewhat flattened from above downwards
- It presents two surfaces- superior and inferior which are convex when full
- The caudal narrow extremity is the neck and it joins the urethra

Relations

- They vary according to the amount of the contents and sex
- The ventral surface is related to the floor of the pelvis and extends into the abdomen as it distends
- The dorsal surface in the male is related to the rectum, the genital fold, and the terminal parts of the vas deferens, the seminal vesicle and the prostate
- In the female, it is related to the body of uterus and vagina. When the bladder is full, the vertex reaches the rumen and small intestine

Ligaments

- The bladder is fixed in position by three peritoneal folds -the ligaments of the bladder
- The ventral or middle ligament is a median triangular fold extends from the ventral face of the bladder to the floor of the pelvis and abdomen
- In the newborn animal, it is extensive and reaches to the umbilicus
- The lateral ligaments are two and extend on either side of the lateral aspects of the bladder to the lateral wall of the pelvis. Each contains in its free edge a round cord the round ligament, which is the remnant of the fetal umbilical artery
- The caudal part of the bladder has no peritoneal covering and is attached to the surrounding parts by fat and connective tissue.
- The mucous membrane is pale, thin and is loosely attached to the submucous tissue
- It forms numerous folds when bladder is empty and contracted
- It is modified over a triangular area on its dorsal wall close to neck called the trigonum vesicae where the mucous membrane is firmly attached without any folds
- The two cranial angles of the trigonum vesicae present the openings of the two ureters and the caudal angle shows the opening of the bladder into the urethra -internal urethral orifice
- The two urethral orifices are placed near each other on either side of the median line. From each urethral orifice, a fold of mucous membrane passes backward and inward, uniting with its fellow to form a median urethral crest in the first part of urethra.
- The terminal part of ureter after piercing the muscular coat of the bladder and passes for a distance of about 2.5 cm between the muscular and mucous coats before piercing the latter
- This arrangement constitutes a valve, which prevents the return of urine from the bladder into ureter
- The internal urethral orifice lies at the apex of the trigonum

URINARY BLADDER - SPECIES DIFFERENCE

Sheep and Goat

- Resembles the ox

Horse

- Shorter but wider
- It does not extend into the abdomen as forward as in the ox
- Caudal part of the bladder is retro peritoneal

Pig

- It is relatively very large
- When full, it is abdominal in position

Dog

- When empty, it is pelvic in position and when full it is entirely abdominal in position

Rabbit

- It is little elongated.
- It is a thin walled sac supported by median ligament of the bladder ventrally, the remnant of the ventral mesentery

Fowl

- The ureters open into the urodeum of the cloaca. So there is no bladder as such

MODULE-12: MALE GENITAL SYSTEM

Learning objectives

- To know about the male reproductive system and accessory genital glands - placement, attachment, relation and its clinical importance

SCROTUM
(Bull, Ram, Buck, Horse, Dog, Boar, Rabbit, Fowl)

Bull

- The scrotum is a diverticulum of the abdomen situated in front of the inguinal region and lodges the testicles and its appendages
- It is oval in form and slightly compressed from side to side
- It is asymmetrical since the left testicle is larger, more dependent and placed a little further back
- It is long and pendulous and presents a well-marked neck when not contracted
- The scrotum varies in its form under the influence of cold, heat, fatigue and debility

Structure

- It is composed of the following layers

- *Skin* -thick and elastic, flesh coloured and is sparsely covered with short hairs. It is marked centrally by a raphe - the raphe scroti
- This is continued forward on the prepuce and behind on the perineum. Just in front of it have two pairs of rudimentary teats
- The *dartos* is the internal tunic of the abdomen consists of the fibro-elastic tissue and plain muscle and is red in colour
- It forms a septum scroti along the raphe scroti dividing the cavity into two unequal parts to accommodate the testicles, of which the left being larger
- Dorsally, this septum divides into two layers which pass by the side of the penis and becomes continuous with the tunica abdominalis
- At the bottom of the scrotum, fibres connect the dartos closely with the tunica vaginalis (thus indirectly with the tail of epididymis) constituting the *scrotal ligament*.
- The *scrotal fascia* made up of three layers and are derived from oblique and transverse abdominal muscles
    - *Intercolumnar fascia* from the aponeurosis of the external oblique muscle
    - *Cremasteric fascia* from internal oblique muscle
    - *Infundibuliform fascia* from transverse abdominis muscle
- The parietal layer of the *tunica vaginalis,* which forms a fibro serous sac, is continuous with the parietal peritoneum

TOP

Species difference

Ram and Buck

- It resembles ox

TOP

Horse

- It is in the inguinal region
- It is globular
- The skin is dark or black coloured
- The rudimentary teats are in the form of two papillae at the lower margin of the preputial orifice and are not related to scrotum

TOP

Dog

- It is behind the inguinal region
- The skin of scrotum is pigmented and covered sparsely with fine hairs
- The raphe is not distinct

TOP

Boar

- It is situated a short distance from the anus and is not so sharply defined from the surrounding parts as in other animals

TOP

Rabbit

- The scrotal sacs are separate and is situated in the inguinal region

TOP

Cock

- It is absent as testicles are abdominal in position

TESTES AND EPIDIDYMIS
(Bull, Ram, Buck, Horse, Boar, Dog, Rabbit, Cock)

Bull

- The testicles are two elongated oval, compound tubular glands situated in the scrotum and suspended by the spermatic cords
- The long axis of the testis is vertical to the long axis of the body and each is slightly compressed from side to side and presents two faces, two borders and two extremities
- The *lateral surface* is convex and smooth and is covered by the *tunica vaginalis propria*
- The *medial surface* is slightly flattened due to its contact with the septum scroti
- The *free border* is cranial and is convex. The *attached-border* is caudal and is called the *epididymal border*
- This border is nearly straight and the epididymis is attached to it
- The *dorsal* and *ventral* extremities are rounded
- The testicle of an adult bull weighs about 300 gm. and measures 10 to 12 cm long and 6 to 8 cm wide
- The left one is heavier than the right by 30 gm. or more
- The *epididymis* is attached along the caudal border of the testicle and slightly overlaps its lateral surface
- It presents three parts. The dorsal enlarged end is the head
- The middle part is the body and the lower part is the tail. The *head* is large and is closely adherent to the dorsal end of the testicle
- The *body* is narrow and lies along the lateral part of the caudal border of the testicle
- The *tail* is large, attached to the ventral end of the testicle by the *ligamentum epididymis* is continued by the vas deferens

TOP

Species difference

Ram and Buck

- The testicles are relatively larger
- They are broader in proportion to their length

Stallion

- The testicles are smaller but globular
- The long axis of testes is parallel to the long axis of the body and hence the attached border of the testicle is dorsal
- The testicle weighs about 225 to 300 gm. It measures 10 to 12cm long x 6 to 7 cm high x 5 cm wide
- The epididymis is directed upward

TOP

Boar

- Testicles are elliptical in contour

- The long axis is directed upward and backward
- The spermatic cord is large and the cremaster muscle is well developed
- The epididymis is closely attached to the testicle. Its tail is very large and forms a blunt conical projection at the caudal end of the testicle

TOP

Dog

- They are small and oval
- They are suspended in an oblique direction upwards and backwards
- Epididymis is large and is along the dorsal border

TOP

Rabbit

- A pair of ovoid testes lies in the scrotum of the adult

TOP

Cock

- The testicles lie ventral to the cranial lobes of kidneys
- The right one is against the dorsal part of the right lobe of liver
- The left one is related to the glandular stomach
- They are bean shaped and bear on the concave border a flattened projection -the rudimentary epididymis

SPERMATIC CORD (OX)

- The spermatic cord consists of structures carried down by the testicle in its migration through the inguinal canal from the abdominal cavity into the scrotum
- It begins at the abdominal inguinal ring where all the constituent structures come together, passes through the inguinal canal and passes over the side of the penis and ends at the attached border of the testicle
- It consists of the following structures,
    - Internal Spermatic arteries
    - Spermatic veins, which form pampiniform plexus around the artery
    - Internal Spermatic nerves run with artery
    - Lymphatics accompanying the veins
    - Internal cremaster muscle
    - Vas deferens
    - Tunica vaginalis (visceral layer)
- Of these, the first four structures are gathered into a round mass, which forms the cranial part of the cord
- They are united by connective tissue interspersed with the internal cremaster muscle
- The ductus deferens forms the postero-medial part of the cord
- It is enclosed in a special fold of tunica vaginalis, hence it is not visible laterally

TUNICA VAGINALIS

- Tunica vaginalis is an evagination of parietal peritoneum passing through the inguinal canal into the scrotum
- When fully developed, it has the shape of a flask with narrow proximal part and a distended distal part

- The *proximal part* contains the spermatic cord and the *distal part* has the testis and epididymis. Like the peritoneum, tunica vaginalis also consists of two layers - parietal and visceral
- The *parietal layer* lines the scrotum and inguinal canal and is continuous with the parietal layer of peritoneum at the abdominal inguinal ring
- The *visceral layer* lines the spermatic cord, testicle and epididymis
- The space between the parietal and visceral layers of the tunica vaginalis, which is a capillary space, contains a small quantity of serous fluid
- This cavity is continuous with the general peritoneal cavity at the abdominal inguinal ring

DESCENT OF TESTES

- During early fetal life, the testicles are situated against the dorsal wall of the abdomen in contact with the visceral surface of the kidneys
- They are attached to the sub - lumbar region by a fold of peritoneum - the mesorchium containing vessels and nerves in its cranial border and in its caudal edge is the tail of the epididymis and two cords of fibrous tissue; one of these is short and connects the tail of the epididymis with the testicle which later becomes the ligamentum epididymis
- The other one is gubernaculum testis, which extends from the tail of the epididymis to the subperitoneal tissue in the vicinity of the future vaginal ring.
- After the middle of fetal life, a pouch of peritoneum, the processus vaginalis, grows downward through the inguinal canal and carries with it fibres of the external cremaster muscle and inguinal extension of the gubernaculum testis
- Simultaneously the tail of the epididymis enters the processus vaginalis, followed by the testicle and mesorchium, till they reach the scrotum
- The gubernaculum blends with the subcutaneous tissue of the scrotum and forms the dartos.
- In ruminants, descent takes place early and is completed at 3 months of fetal age. In the horse, the testes leave the abdominal cavity close to birth
- In dog, the testes are still in the lumbar area at the time of the birth and they descend into the scrotum shortly after birth. In the pig, descent occurs during fetal life and is completed shortly before birth
- Indefinite retention of the testicle, one or both, in the abdominal cavity or inguinal canal constitutes cryptorchism and such testes are non-spermiogenic
- It is common in pigs and horses. In some mammals it is normal as in the elephant and such animals are called testiconda.

VAS DEFERENS
(Bull, Ram, Buck, Stallion, Boar, Dog, Rabbit, Cock)

Bull

- The ductus deferens or vas deferens extends from the tail of the epididymis to the pelvic part of the urethra
- It is at first, pursues a very tortuous course upwards along the caudal border of the testicle
- It then becomes straight and runs in the caudal border of the spermatic cord through the inguinal canal, deviates from the other structure at the vaginal ring, turns backwards into the pelvic cavity. For some distance it lies in the free edge of the genital fold by which it is kept attached to the lateral walls of the pelvis
- The two ducts passes backward towards the dorsal face of the bladder, where they leave the genital fold, incline medially to reach the caudal part of the bladder
- They open at the roof of the beginning of the urethra as slit - like openings - the ejaculatory orifices on either side of the colliculus seminalis, medial to the openings of the vesiculae seminalis
- From its origin to the dorsal face of the bladder, it has a uniform diameter of about 3mm
- Then they form an enlargement - bulbus part or ampulla, which is 10 to 12 cm long and 1.2 to 2.5 cm wide

TOP

Species difference

Ram and Buck

- It resembles bull

TOP

Stallion

- The caliber is about 6 mm.
- The first part of the course has no relation to the testicle
- The ampullated part is 15 to 20 cm long and 2 cm wide
- The genital fold is wider and hence the two ducts are apart from each other
- The vas deferens and the duct of seminal vesicle open in a common ejaculatory orifice on the side of the colliculus seminalis
- The vas deferens is not tortuous and not related to any border of the testicle

TOP

Boar

- The vas deferens in its testicular part is flexuous and is closely attached by the tunica vaginalis
- It forms no distinct ampulla

TOP

Dog

- The ampullae are narrow

TOP

Rabbit

- The dilated terminal portion of the duct enters the ventral wall of the seminal vesicle dorsal to the bladder

TOP

Cock

- The vas deferens are extremely tortuous ducts which arise from the epididymis, pass backwards and open into urodeum on the summit of a papilla lateral to the ureter

TO

UTERUS MASCULINUS (UTRICULUS PROSTATICUS)

Bull

- It is vestigial and is the homologue of the uterus and vagina. It is inconstant.

Stallion

- It is a fetal remnant of the Mullerian duct and is situated centrally on the caudal part of the dorsal surface of the bladder.

- It is flattened, tube like about 7.5 to 10 cm long.
- Its cranial part is narrow and lies in the genital fold and gives off two slender cornua.
- The caudal end of the tube passes under the isthmus of prostate and opens into the urethra on the summit of the colliculus seminalis or joins the duct of the seminal vesicle or has a blind end.

Ram and Buck

- It resembles bull

Dog

- It is in the form of a small compressed sac in the colliculus seminalis

Boar

- Small and appears to be inconstant

Rabbit

- It is inconstant

Cock

- Absent

ACCESSORY SEX GLANDS

- Seminal vesicle
- Prostate and
- Cowper's gland

SEMINAL VESICLE
(Bull, Ram, Buck, Stallion, Boar, Dog, Cock, Rabbit)

Bull

- These are two compact glandular organs with a lobulated surface
- They are situated on the dorsal surface of the bladder
- Dorsally they are related to rectum. It is about 10 to 12 cm, long 5 cm wide and 3 cm thick
- Each consists of a thick walled tube folded on itself in a tortuous manner
- The excretory ducts open on either side of the colliculus seminalis lateral to the openings of the vas deferens, at the ejaculatory orifices

TOP

Species difference

Ram and Buck

- It resembles that of bull

TOP

Stallion

- They are two elongated and pyriform sacs
- Each consists of a rounded blind end - fundus, a middle narrow part- body and a caudal constricted part - neck or duct. Each is about 15 to 20 cm long
- The excretory duct opens in common with or along side the vas deferens in a pouch of mucous membrane on the side of colliculus seminalis

TOP

Boar

- The glands are exceedingly large
- They are distinctly lobulated and glandular
- About half a dozen or more large thin walled ducts emerge from the medial surface of each and converge to a smaller excretory duct and this terminates at a slit like opening on the colliculus seminalis

TOP

Dog & Cock

- Absent

TOP

Rabbit

- It is medially situated and opens into the prostatic segment of the urethra immediately in front of the colliculus seminalis

PROSTATE
(Bull, Ram and Buck, Stallion, Boar, Dog, Rabbit, Cock)

Bull

- The prostate is a musculo-glandular organ, which is pale yellow in colour. It consists of two parts - the body and pars disseminata
- The body is a small mass, which stretches across the dorsal surface of the neck of the bladder and the origin of the urethra
- The pars disseminata surrounds the pelvic part of the urethra
- The secretion is taken by prostatic ducts which open into the urethra behind the colliculus seminalis in rows - two of which are between the two folds of mucous membrane passing backwards from colliculus seminalis while two others occur on either side lateral to the folds

TOP

Ram and Buck

- It is entirely disseminate
- There is no body portion

TOP

Stallion

- It is a lobulated gland lies on the neck of the bladder and is large and consists of two lateral lobes and a connecting isthmus
- The *superficial face* of the lobes is related to the rectum and the *deep face* is concave and is related to the seminal vesicle
- The isthmus is related ventrally to the uterus masculinus, vas deferens
- There are 15 to 20 ducts on either side opening, lateral to the ejaculatory orifices

TOP

Dog

- It is very large, globular and surrounds the neck of the bladder
- A median furrow indicates its division into two lobes
- The ducts are numerous

TOP

Boar

- The body of the gland overlies the neck of the bladder
- It is concealed by the seminal vesicle

TOP

Rabbit

- The prostate lies in the dorsal wall of the more caudal part of the seminal vesicle

TOP

Cock

- Absent

URETHRA
(Bull, Ram and Buck, Stallion, Boar, Dog, Rabbit, Cock)

Bull

- It is a long mucous tube extending from the neck of the bladder to the tip of glans penis
- It passes backwards on the floor of the pelvis, turns around the ischial arch forming a sharp bend and then passes forward to be included in the body of the penis
- It has therefore pelvic and extra pelvic or penile parts
- The *pelvic* part is 12 cm long and is relatively small and uniform in diameter
- The urethral muscle encloses it ventrally and laterally and is very thick
- It is related to the rectum and prostate above, the obturator muscles below and the Cowper's gland laterally
- The *extra pelvic* or *penile* part passes between the two crura of the penis turns forward and is included in the body of the penis
- Here the corpus spongiosum and bulbo-cavernous muscle covers it. The tube forms an enlargement at its beginning, the bulbus urethrae
- It then gradually diminishes in diameter and very small at its termination, forming processus urethrae

- The opening from the bladder into the urethra is termed internal urethral orifice, it is closed except during urination
- The terminal opening is known as external urethral orifice.
- The colliculus seminalis is a rounded prominence, situated medially on the dorsal wall about 5 cm behind the internal urethral orifice and on it are two slit-like openings situated close together
- These are the ejaculatory orifices at which the vas deferens and the excretory duct of seminal vesicle open
- The urethral crest is a median ridge of mucous membrane in the dorsal wall of the urethra
- The crest extends forward from the colliculus, while two mucous folds pass backward from the colliculus
- A little lateral and caudal to the colliculus are the openings of the prostate and behind are the ducts of the Cowper's gland

TOP

Species difference

Ram and Buck

- The urethra lies in a groove on the ventral surface of the corpus cavernosum.
- Its terminal part projects commonly about an inch and half beyond the glans penis, forming twisted processus urethrae.

TOP

Stallion

- Pelvic part is 10 to 12 cm long and 5 to 6 cm in diameter.
- The extra pelvic part is 1.5 cm in diameter.
- The colliculus seminalis presents on either side a small diverticulum in which the vas deferens and the duct of seminal vesicle opens
- Lateral to this are the openings of the prostatic ducts and further back are openings of the ducts of the Cowper's gland

TOP

Boar

- It has a very long pelvic part and covered by a thick urethral muscle except dorsally where there is a dense fibrous layer

TOP

Dog

- The bulb of the urethra is well developed

TOP

Rabbit

- The external urethral orifice is placed dorsally and little cranially

TOP

Cock

- Absent

PENIS
(Bull, Ram and Buck, Stallion, Boar, Dog, Rabbit, Cock)

Bull

- The penis is the male copulatory organ and is composed of white fibrous tissue and a little erectile tissue
- It extends from the ischial arch forward between the thighs to the umbilical region of the abdominal wall
- It is supported by the fascia penis and its prescrotal part is situated in a cutaneous pouch -the prepuce
- It is cylindrical in form and measures in an adult bull about 90 cm It may be divided into 3 parts -the root, body and glans
- The root is attached to the lateral parts of the ischial arch by two crura, which converge and unite below the arch to form the root of the penis
- The urethra passes over the arch between the crura, curves forward to become incorporated in the substance of the penis
- The body begins at junction of the crura and forms the bulk of the organ
- It is flattened from above downward and it presents four surfaces -*dorsal, ventral and two lateral surfaces*
- At its origin it is attached to the symphysis ischii by two strong bands -the suspensory ligaments of the penis
- Just behind the scrotum it forms a S -shaped curve-the sigmoid flexure in which 30 cm of the penis is folded which is released during erection
- The glans penis is the free end of the organ and is 8 cm long. Its extremity is pointed and twisted
- The twisted end shows ventro-laterally a groove and the urethral process projects as a ridge in the groove. At the end of the process is the external urethral orifice
- The penis is principally made up of white fibrous tissue
- It is remarkably dense and firm even in the non-erect condition
- The organ undergoes very little enlargement during erection but it becomes more rigid

TOP

Species difference

Ram and Buck

- The free extremity is very distinctive with well-developed urethral process continued beyond the glans penis

TOP

Stallion

- It is shorter but has a larger diameter, the length being about 50cm in the quiescent state
- It undergoes 50% increase during erection
- The erectile tissue is very rich in elastic and muscular tissues and hence very soft
- The glans is enlarged and its base forms a prominent margin -the corona glandis. There is a depression in the glans known as fossa glandis
- The urethra protrudes into the fossa glandis as the free urethral process
- Dorsal to the urethral process, the fossa forms a diverticulum, the urethral sinus, which is the site of accumulation for smegma

TOP

Boar

- Resemble in general to that of the ox
- The sigmoid flexure however is prescrotal
- The cranial part is spirally twisted especially in erection

TOP

Dog

- In the cranial part there is a bone-os penis, which is grooved ventrally for the lodgment of the urethra
- The glans is very long and is extended over the entire length of the os penis
- The cranial part of the glans penis is cylindrical with pointed free end
- In the caudal part, there is a rounded enlargement, the bulbous glandis
- Both are composed of erectile tissue

TOP

Rabbit

- From the root, the body of the penis first proceeds forward and just before reaching testicles, it almost makes a U turn backward. Therefore the glans penis is directed backward
- Its free extremity is known as pars libera

TOP

Cock

- Absent
- The copulatory apparatus is placed at the ventral aspects of the caudal end of cloaca
- It comprises of two papillae of vas deferens, two vascular bodies, a phallus and two lymphatic folds

PREPUCE
(Bull, Ram, Buck, Stallion, Boar, Dog, Rabbit, Cock)

Bull

- The prepuce or sheath is a tubular sheath covering the cranial free portion of the penis in non-erect state
- The preputial cavity is 35 to 40 cm long and narrow and consists of external and internal layers
- The *external layer* extends from the scrotum to about the umbilicus
- This layer is continuous with the skin at the orifice and is loosely attached to the adjacent structures by a large amount of connective tissue
- The *internal* or *penile layer* extends to the tip of the glans. This layer is loosely attached to the body of the penis and closely attached to the glans
- The free surface has number of longitudinal folds. Both layers are hairless modified skin. Cavity of the prepuce is rather small but capable of considerable dilatation
- The glans is in the caudal half of the cavity. The preputial orifice is the opening of the prepuce
- It is about 5 cm behind the umbilicus and is about 2.5 cm in diameter but capable of dilatation, faces downward and a little forward and are hidden by number of long hairs.

TOP

Species Differences

Ram and Buck

- The prepuce is relatively short

TOP

Stallion

- It is shorter but wider. The orifice has no hairs around it
- The prepuce is a double invagination of the skin, which contains and covers the free or prescrotal part of the penis, which consists of two layers - external and internal
- The *external layer* of sheath extends from the scrotum towards the umbilicus where the external layer is reflected dorsally and backwards forming the margin of the preputial orifice
- Dorsally it is continuous with the integument of the abdominal wall. It is marked by a median raphi preputii
- The *internal layer* passes backward from the preputial orifice a distance of about 15 to 20 cm and is then reflected forward until it approaches the orifice, when it again reflected backward. It thus forms within the cavity of the sheath a secondary tubular invagination, the prepuce proper
- Its orifice is surrounded by a thick margin, the preputial ring

TOP

Boar

- The preputial cavity is very long and partially divided by a circular fold into a *caudal narrow part* and a much *wider cranial part*
- In the dorsal wall of the wide part, there is a circular opening, which leads to a *cul-de-sac*, the preputial diverticulum

TOP

Dog

- As in bull

TOP

Rabbit

- The prepuce is well developed

TOP

Cock

- Absent

MODULE-13: FEMALE GENITAL SYSTEM

Learning objectives

- To understand the different segments of female reproductive system - its location, contour and attachments
- To have an idea about mammary gland of various species

OVARY

(Cow, Ewe and Doe, Mare, Sow,Bitch, Rabbit, Hen)

Cow (View image)

- The ovaries are two small oval glands, which secrete the ova and are situated a little above the middle of the lateral margin of the pelvic inlet
- It is attached to the lateral abdominal wall by the cranial part of the broad ligament of the uterus - mesovarium
- Each measures about 3.5 to 4 cm long 2.5 cm wide and1.25 cm thick, weighs about 15 to 20 gm
- The size and shape of the ovary are affected by age, ovarian follicle and corpusluteum.
- The ovary presents two surfaces, two borders and two extremities
- The *medial* and *lateral surfaces* are smooth and rounded
- The *attached* or *mesovarial border* is considered as hilus, which is convex, where the vessels and nerves reach the gland at this border
- The free border is also convex. The *cranial tubal* extremity is rounded and is related to the fimbriated end of the fallopian tube
- The *uterine* or *caudal extremity* is narrower and is connected to the uterus by the ovarian ligament

TOP

Species difference

Ewe and Doe

- They resemble in general those of ox with few exceptions
- The ovaries are almond shaped and are half inch or more (1.5cm) long

TOP

Mare (View image)

- Bean shaped and much larger, 7 to 8 cm long, 3 to 4 cm thick, weighs 70 to 80 gm
- Situated in the sublumbar region under the 4^{th} or 5^{th} lumbar vertebra
- The notch on the free border leads into a depression the ovulation fossa, where ovulation takes place

TOP

Sow (View image)

- Ovaries are concealed in a peritoneal pouch called ovarian bursa.
- They are round and irregular lobulated surface seen due to the presence of rounded prominences on its surface.

TOP

Bitch (View image)

- Small, elongated, oval and flattened; average length 2 cm
- Situated a little behind (1 to 2 cm) the caudal pole of the corresponding kidney
- The two layers of the ovarian bursa continue to the cornu of the uterus consisting mesosalphinx and the ovarian ligament
- The bursa has a slit-like opening ventrally

TOP

Rabbit

- Ovaries are elongated
- Pinkish in colour and about 1cm long and 4mm thick

TOP

Hen

- Only left ovary is present since the right one is usually rudimentary
- The left ovary is situated in the dorsal part of the abdominal cavity, attached to the dorsal wall below the last two ribs
- It has the left lung above and in front; the cranial lobe of the kidney above proventriculus and spleen below; caudal venacava medially
- The ovary consists of a mass of loosely connected, yellowish and round objects of different sizes, each containing an ovum
- It is in the form of bunch of grapes in mature stage

OVIDUCT
(Cow, Ewe and Doe, Mare, Sow, Bitch, Rabbit, Hen)

Cow (View image)

- Uterine or Fallopian tubes act as excretory ducts of the ovaries since they convey the ova from the ovaries to the uterus
- They are not in direct continuity with the gland but are partly attached to them.
- Each is 20 -25 cm long, extending from the cranial extremity of the ovary to the extremity of the uterine horn at the uterine end
- The tube is rather small but becomes wider and funnel shaped towards the ovaries
- Each is enclosed in a peritoneal fold derived from the broad ligament of the uterus - mesosalphinx
- The uterine extremity communicates with the uterine horn by the large, funnel shaped ostium uterinum tubae while the ovarian end is wide and forms the infundibulum whose margin is irregular and fimbriated
- It presents a small opening - the ostium abdominale tubae by which it communicates with the peritoneal cavity
- The ovarian extremity of the oviduct appears normally to be applied to the ovary, so that the extruded ova pass into it and are conveyed to the uterus

TOP

Species difference

Ewe and Doe

- There is no demarcation between the uterine tube and the horn of the uterus
- The tube is very flexuous near the infundibulum (View image)

TOP

Mare

- 20 to 25 cm long but more flexuous (View image)
- The oviduct joins the uterine horn very abruptly
- The frimbriae are more extensive and the uterine orifice is minute

TOP

Sow

- Less flexuous (View image)
- The fimbriated end has a large abdominal opening

TOP

Bitch

- Small and slightly flexuous
- Its abdominal opening is large and uterine opening small
- It passes at first forward in the lateral part of the ovarian bursa and then backward in the medial part of the pouch
- The fimbriated extremity lies chiefly in the bursa but part of it often protrudes through the opening in the bursa

TOP

Rabbit

- The oviduct is slender, flexuous about 5 cm length

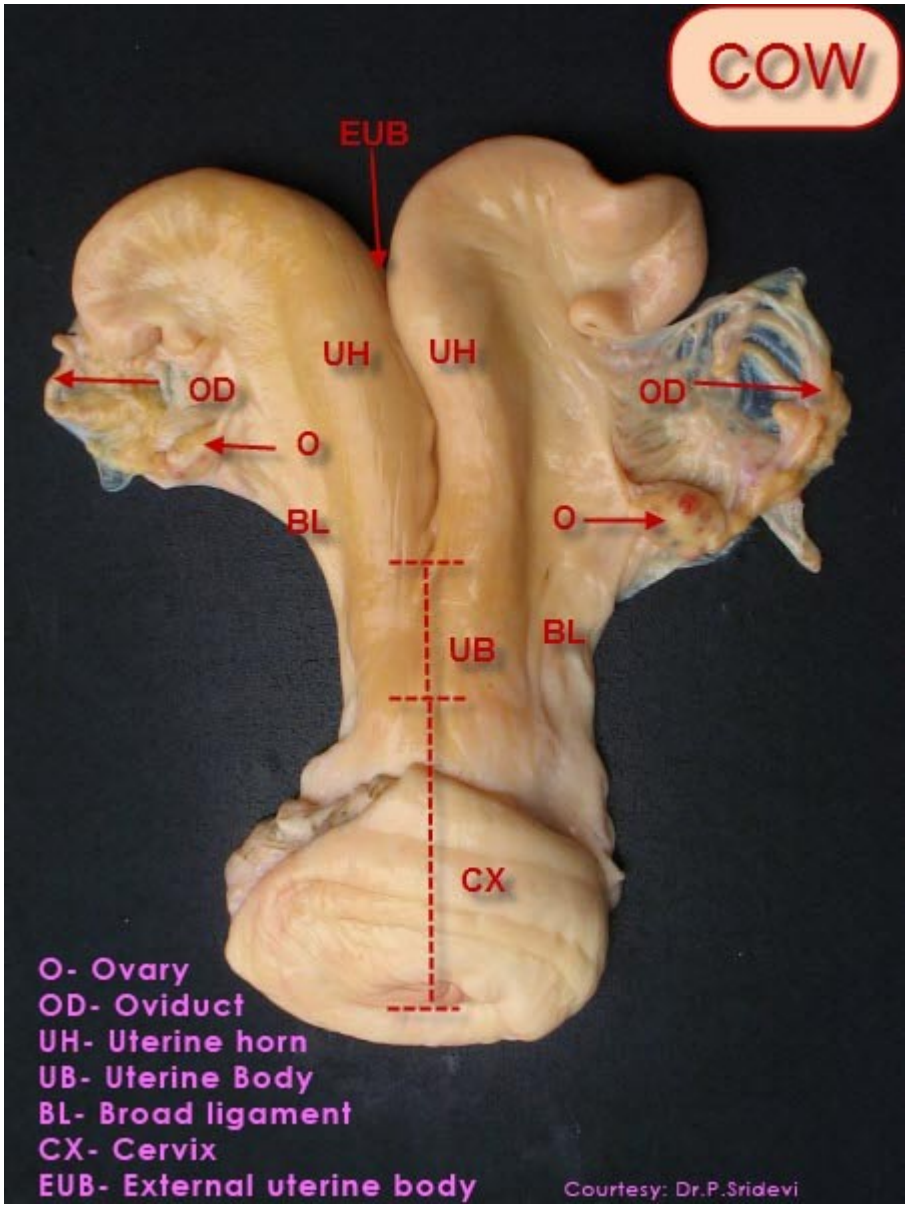
TOP

Hen

- Only the left oviduct is developed. It is dilatable, convoluted tube about 80 cm in length in the laying hen, and extends backwards against the dorsal part of the left body wall in relation to the ilium and ischium
- It opens into the urodeum of the cloaca lateral to the left ureter
- It is suspended between two layers of a fold of peritoneum, which forms the membranous dorsal and ventral ligaments of the oviduct
- The ventral border of the dorsal ligament attached to the duct, while its dorsal border is attached to the dorsal body wall
- The ventral ligament has a free ventral border, which is thick and muscular.
- The cranial end of the oviduct has a delicate funnel shaped structure with long process enclosing the ovary
- Entrance to the oviduct is by a slit-like opening the ovarian end and its exit is into the cloaca.
- The oviduct may be divided into five parts, namely, infundibulum, magnum, isthmus, uterus and vagina each preserving its own structure and physiological function
    - The infundibulum is the funnel-shaped structure, with delicate walls narrowing to a neck of 2.3 cm long. Its function is to grasp the ovum as it is released from the ovary
    - The magnum or albumin secreting part forming the major part of the duct is about 40 cm long and is remarkable for the thickness of the walls
    - It secretes about 40 percent of the albumin of the egg
    - The isthmus about 12 cm long connects the albumin region with a thinner walled uterus
    - The lumen is narrow and secretes the shell membrane and some albumin
    - The thin walled uterus or “shell gland” is wide and about 12 cm long. It terminates in a sphincter muscle
    - The function is to secrete about 40% of total egg albumin, formation the calcareous shell and to certain extent the pigment formation
    - The vagina is 12 cm long and it succeeds the sphincter. The walls are very muscular
    - The outer shell cuticle and perhaps pigment are formed in this part
    - Oviposition takes place in the vagina. It terminates in the cloaca
- The mucous membrane of the oviduct presents longitudinal folds
- The folds are highest in the albumin secreting part; further back the folds are not so high and tend to be transverse or oblique

UTERUS (COW)

- The uterus is musculo-membranous sac continuous with the oviduct in front and vagina behind
- It lies almost entirely in the abdominal cavity in the adult and is attached to the upper part of the flank about a handbreadth, below the level of tuber coxae by two extensive peritoneal folds -the broad ligaments of the uterus
- It consists of two horns, a body and cervix



- The horns or cornua are situated in the abdomen and are about 35 to 40 cm long
- They taper gradually to the free end so that its junction with the fallopian tube is not abrupt
- The horns curve downward, forward, outward and then turn backward and upward thus forming a spiral coil
- The dorsal border is attached to the lateral part of flank by broad ligament.
- The body is about 3 to 4 cm long. It is cylindrical and is related to the rectum above and the bladder below.

- The cervix is about 10 cm long and its wall is very dense and more than 3 cm thick. Part of it projects into the vagina and is not visible externally but may be felt through the vaginal wall and the space between the projection and the vagina is called as fornix (Click to see the fornix)
- The lumen or the cervical canal is spiral, tightly closed and difficult to dilate. It is clearly marked off from the body of uterus and vagina so that the two orifices of the canal are distinct
- The vaginal part of the uterus is so fused ventrally with the vagina .So the fornix is present dorsally and almost absent ventrally
- The cervix and body communicate through orificium internum uteri. (Click to see the image)
- The cavity of the uterus is largely obliterated in the non-pregnant state by the contraction of its wall and the folds of mucous membrane
- The cavity of the neck opens into the vagina at the orificium externum uteri or os uteri. In front, the uterus communicates with the oviducts
- The mucous membrane of the body and horns presents a large number of oval prominences called maternal caruncles, about 100 in number, irregularly scattered or arranged in rows of about a dozen or more. In the non-gravid state these are about 15 mm. long and a little less in width and thickness
- During pregnancy they become enlarged and pedunculated, being about 10 to 12 cm long, 3 to 4 cm wide, 2 to 2.5 cm thick
- The deep face has a hilus at which the vessels enter. The rest of the surface has a spongy appearance, due to numerous crypts, which receive the chorionic villi of the fetus
- The mucous membrane of the cervix is pale and forms numerous folds
- The folds are arranged in several series, which obliterate the lumen
- At the external uterine orifice, the folds form rounded prominences arranged circularly which project into the cavity of vagina
- There are no glands in the cervix but a thick mucous is secreted by goblet cells.

Attachments

- The body and horns are attached by extensive peritoneal folds - broad ligaments of uterus to the lateral part of flank
- The ligaments contain the vessels and nerves of uterus and ovaries, connective tissue and a large amount of unstriped muscular fibres, which are continuous with the uterus
- The broad ligaments on either side gives a fold to the uterus, which extends up to the abdominal inguinal ring known as round ligaments

UTERUS
(Ewe and Doe, Mare, Sow, Bitch, Rabbit)

Species difference

Ewe and Doe

- The uterus resembles that of the cow. The horns are four or five inches long (Click here for the image)
- The junction of the uterine horns with the fallopian tubes shows no clear distinction. They are coiled in a close spiral.
- The body is less than an inch long.
- The cotyledons are much smaller than those of the cow and have a depression on their free surface.
- The cervix is about an inch and a half long.
- The lumen of the cervix is closed by reciprocal prominences and depressions of the mucous membrane.
- The external urethral orifice is in the ventral part of the vagina

TOP

Mare (Click to see the Uterus)

- The body is situated partly in the abdomen and partly in the pelvis; it is 18 to 20 cm long

- The cornua are 25 cm long and curved, the ventral border being convex. They are situated entirely in the abdomen
- The junction of the oviduct and horn is abrupt.
- The cervix is 5 to 7.5 cm long and the cervical canal is straight
- The mucous membrane has no cotyledons

TOP

Sow (Click here for the image)

- The body is only 2 inches long
- The horns are extremely long and flexuous and freely movable due to the large extent of broad ligaments
- In non-pregnant animals, they are arranged in numerous coils like small intestine
- The extremities of the horns taper to the size of the fallopian tubes
- The neck has remarkable length
- The fornix is absent

TOP

Bitch (Click here for the image)

- The body is very short about 2 to 3 cm long and the cornua are very long, (12 to 15 cm) straight and are situated in the abdomen
- They diverge from the body in the form of V-shape towards the kidneys. The neck is very short
- The horns are not tapered gradually
- The round ligaments are passing into the inguinal canal enveloped by a peritoneal pouch called processus vaginalis
- The gravid uterus is abdominal and extends to the stomach and liver
- Cotyledons are absent

TOP

Rabbit

- The right and left uterus is separated for their entire length
- The uterus has a small body and long tubular horns. The length of the horn may be one meter and presents numerous **U** shaped coils
- The cervix is elongated and presents rounded prominences within the lumen. This arrangement helps in forming interdigitation and provides better occlusion during necessity
- The wall of the cervix is continuous with that of vagina and there is no cervical projection within the vagina

VAGINA
(Cow, Ewe and Doe, Mare, Sow, Bitch, Rabbit)

Cow

- The vagina is a tubular passage extending from the neck of the uterus to the vulva
- It is about 25 to 30 cm long and there is no line of demarcation between it and the vulva
- It is related above to the rectum, below to the bladder and urethra, and laterally to the pelvic wall. Half of the vagina is retroperitoneal
- The mucous membrane is highly elastic and has no glands
- In the ventral wall of the vagina, between the muscular and mucous coats, there are two ducts along with the length of the tube called as canals of Gartner, which open on either side of the external urethral orifice. The cranial end of the vagina is occupied by cervix
- The caudal part is directly, continuous behind with the vulva

- The only line of demarcation is a transverse fold- hymen, which covers the external urethral orifice

Ewe and Doe

- It is three or four inches long. Its ventral part contains numerous lymph follicles

Mare

- Shorter in length 15 to 20 cm It is less capacious
- Vaginal wall is thinner, canals of Gartner is generally absent

Sow

- It is small in caliber, about 4-5 inches and medium size
- The mucous membrane is plicated

Bitch

- It is relatively long and narrow
- The fornix is indistinct
- The mucous -membrane forms longitudinal folds

Rabbit

- It is an elongated tube

VULVA (COW)

- The *vulva* or *urogenital sinus* is the terminal part of the uro-genital tract and is continuous in front with the vagina and opens externally at the vulvar cleft below the anus
- It is about 10 to 12 cm long and is related above to the rectum and anus and below to the floor of the pelvis and laterally to the sacrosciatic ligaments
- The vulvar cleft is a vertical slit 10 to 12 cm high, margined by two prominent-lips the labia vulvae
- They are thick, wrinkled and unite above and below to form the dorsal and ventral commissures respectively
- Both commissures are acute; the dorsal one is below the anus while the ventral one is pointed and lies behind and below the level of the ischial arch and has a number of long hairs on it
- The clitoris is composed of erectile tissue and is the homologue of the penis
- When the lips are drawn apart a fossa is noticed at the ventral commissure called the fossa clitoridis, which lodges the pointed free end of the clitoris called glans clitoridis
- Below and in continuation with the glans is the corpus clitoridis 10 to 12 cm long, which is formed by the union of the two crura clitoridis, which are attached to the ischial symphysis by suspensory ligaments
- The external urethral orifice is in the form of a longitudinal slit about 10 to 12 cm from the ventral commissure on the ventral wall
- It is covered by a fold of mucous membrane, the free end of which is directed backwards. Beneath this, is a blind pouch the suburethral diverticulum about 3.5 cm long
- The mucous membrane of the vulva is pink or yellowish red in colour. At the floor a pair of large and some small vestibular glands are present

VULVA
(Ewe and Doe, Mare, Sow, Bitch, Rabbit)

Ewe and Doe

- An inch or more in length
- There is a very small diverticulum below the urethral orifice, which is similar in the Goat
- The vestibular glands are inconstant. If present, they may be a size of a small bean
- The labia are thick and the ventral commissure is pointed and projects downward
- The clitoris is short and the glans is concealed in the fossa clitoridis

TOP

Mare

- The ventral commissure is rounded and thick
- Suburethral diverticulum is absent
- Glans clitoridis is more prominent and the fossa clitoris is wide
- Clitoris is short and thick

TOP

Sow

- The labia are thick and covered with wrinkled skin
- The clitoris is in the form of small projection. The dorsal commissure is rounded and ventral is pointed
- The clitoris is long and flexuous
- The fossa clitoris is located at an inch cranial to the ventral commissure

TOP

Bitch

- The labia are thick and ventral commissure is pointed
- The clitoris is flat. The corpus clitoridis is not erectile whereas glans clitoridis is erectile
- A fold of mucous membrane extends backwards over the glans and fossa
- The mucous membrane is red

TOP

Rabbit

- The vulval lips are pointed downward

FEMALE URETHRA

Cow

- It refers the part represented in male urethra from the internal urethral orifice of the bladder to the colliculus seminalis
- It is situated centrally and is related to the pelvic floor below and vagina above
- It is about 10 to 12 cm long. It is very narrow and not very dilatable
- The external orifice is about 10 to 12 cm from the ventral labial commissure

Ewe and Toe

- Resembles the cow

Mare

- 5 to 7.5 cm long and is remarkably dilatable

Sow

- Three inches long
- Its caudal part is fused with the vagina and produces a corresponding elevation of the floor of the latter

Bitch

- About 7 cm long

Rabbit

- It is an elongated tube

MAMMARY GLAND - COW

- The mammary glands are modified cutaneous gland associated functionally with the genital organs
- They are popularly known as *"Udder"*. They are compound saccular glands, four in number and two on the either side of the median line
- They extend from caudal part of the abdomen to the floor of the pelvis and thus lie between the thighs
- Each gland is flattened from above downwards and presents a *base* and an *apex and two lateral faces*
- The *lateral face* is convex and the medial surface is flattened. The *base* is slightly concave and slopes downwards and forwards in adaptation to the abdominal wall
- The appearance of the udder varies greatly, depending on maturity and functional status of the individual and also based on the breed character
- The base of each gland is attached to the abdominal wall by means of a well-developed *suspensory apparatus*, which is attached to the ventral part of pelvic symphysis by means of the *subpelvic tendon*. This sub-pelvic tendon attaches the *prepubic tendon* to the ventral part of the pelvic symphysis
- The *suspensory apparatus* (ligament) consists of four sheets of tissue.
- Of which two are median and two are lateral in position. The median laminae are well developed and median in position and are chiefly made up of yellow elastic tissue
- The two glands of either side are separated by the double septum, which attaches to the medial flat surface of the gland
- The lateral laminae are made up of dense connective tissue
- It arises from the subpelvic tendon caudal to the udder
- It descends downwards, while reaching the abdominal floor they diverge into median and lateral laminae
- The lateral laminae then extend downward over the udder and divide into superficial and deep layers
- The superficial layer attaches to the skin where it reflects off the udder to the medial face of the thigh
- The deep layer is thicker and attached to the convex lateral surface of the udder by numerous lamellae, which pass into the gland
- The caudal part of the base has the *supramammary lymph gland* and a considerable amount of fat in relation to it
- It is customary to divide the udder into four quarters. There is neither septum nor visible division between the two quarters of the same side
- Each quarter is independent of the other as each is a compound saccular gland
- A teat continues the apex of each quarter, which is about 7-8 Cm long
- A prominent inter *mammary groove* marks the division of the udder into right and left halves. A single teat continues the apex of each quarter
- Each teat has a single *lactiferous duct* (Ductus lactiferous), which widens superiorly into a roomy *lactiferous sinus* (Sinus lactiferous), popularly known as *milk cistern*

UDDER

Ewe and Doe

- They are two in number and relatively large
- They are approximately globular but flattened on the septal side

Mare

- There are only two glands, which are not divided into quarters smaller than those of the cow, each gland has a single teat and the apex presents two openings close together
- Two lactiferous ducts lead into the sinus. Each teat is 2.5 Cm - 5 Cm long

Sow

- They are usually ten or twelve in number and are arranged in two rows as in the bitch
- Each teat has commonly two ducts

Bitch

- The glands are 10 in number arranged in two series of five each as pectoral, abdominal and inguinal
- The apex of each teat has 6-10 openings on it

Rabbit

- Four or five pairs of nipples present on the ventral surface of the abdomen and thorax
- The lactiferous sinus is not prominent

MODULE-14: LYMPHOID ORGANS

Learning objectives

- To develop a concept about spleen and thymus the two vital players in the team of lymphoid system and to realize its anatomical importance in immunity

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SPLEEN - OX

- The spleen is the largest of the lymphoid organs, situated on the left face of the rumen and elliptical in outline
- It is bluish-red or purple in colour and measures about 50 cm long and 15 cm broad and weighs about 900 gms
- It presents two surfaces, two borders and two extremities
- The parietal surface is convex and is applied against the diaphragm
- It presents a narrow, angular, elongated area in the upper part, close to the cranial border without peritoneal covering and directly adherent to the diaphragm
- The visceral surface is concave and is related chiefly to left side of the rumen and a narrow adjacent area of the reticulum. About one half of the visceral surface in front is attached to the rumen and is denuded of peritoneal covering (Click to view the spleen of all domestic animals)
- The hilus is situated on the dorsal third of the visceral surface nearer the cranial border
- The dorsal extremity lies under the dorsal ends of the last two ribs
- The ventral extremity is opposite the 8th or 9th rib about a hand's breadth above its sternal end

SPLEEN (SHEEP AND GOAT)

- Spleen is oyster shell-shaped or triangular approximately
- The wider end or base is dorsal. Long axis is oblique and corresponds to a line drawn from the vertebral end of the last rib to about the 10^{th} intercostal space
- The dorsal end is attached to the left crus of the diaphragm under last two ribs
- The hilus is on the visceral surface as a round depression
- The ventral end is thinner and situated opposite to the 11^{th} rib

SPLEEN (HORSE)

- It is situated in the left parachondriac region on the left part of the greater curvature of the stomach
- It is scythe shaped
- It weighs about 1 kg
- The parietal surface is convex and is related to diaphragm
- The visceral surface is concave and presents a ridge, which divides this face into unequal areas
- The hilus is on a groove situated on the ridge
- The area in front of this ridge is the gastric impression and behind the ridge is the colic impression left by parts of colon
- The cranial border is concave whereas the caudal is convex
- The base is beveled and presents the renal impression

SPLEEN (PIG)

- Long and narrow extends dorso-ventrally along the left part of the greater curvature of the stomach
- The dorsal end is smooth and convex and lies under the vertebral ends of the last three ribs
- The parietal surface is smooth and convex
- The visceral surface is concave and presents a longitudinal ridge on which the hilus is situated
- This divides the surface into nearly equal gastric and intestinal areas, which are in contact with the stomach and colon respectively

SPLEEN (DOG AND CAT)

Dog

- The spleen is bright red in colour and weighs 50 gm
- It is falciform, long and narrow. It is roughly human- foot print shaped structure
- Its dorsal end is narrower and is ventral to the vertebral end of the last rib and first lumbar transverse process
- The ventral end is wider and is variable in position

Cat

- Spleen is spear shaped

SPLEEN (RABBIT AND FOWL)

Rabbit

- It is elongated and spatula shaped structure

- Dark brown in colour
- Proximal end is pointed and the distal end is blunt
- Cranial border is convex and the caudal border is irregular
- It is extended dorso-ventrally along the greater curvature of the stomach

Fowl

- The spleen is a reddish brown, rounded body situated dorsally and to the right of the junction of the proventriculus and gizzard
- Accessory spleens are also noticed

THYMUS - OX

- The thymus is a lymphoid organ and is well developed only in the last stages of fetal life and a few months after birth
- After birth it undergoes atrophy. In the calf it is pale in colour, distinctly lobulated and consists of thoracic and cervical parts
- The *thoracic part* occupies the greater part of the cranial mediastinal space upto the pericardium
- Its *left face* is in contact with the chest wall and the left lung
- Its *right face* is molded on the great vessels in front of the heart
- The *cervical part* forms the bulk of the gland and consists of right and left lobes, which extend the ventro-lateral aspects of the trachea from the thoracic inlet to the thyroid gland
- It weighs about 435 to 600 gm. at five or six weeks of age

THYMUS - SPECIES DIFFERENCE

Sheep and Goat

- It resembles ox

Horse

- In the newborn foal it is greyish pink and consists of *right* and *left lobes*
- The greater part of the gland is situated in the cranial mediastinum but the two lobes are continued into the neck by a chain of lobules, which lie on the trachea along the course of the carotid artery extending sometimes as far as the thyroid gland
- The cervical part however is very variable

Pig

- In young ones, it is very large extending to the larynx or even to the mandibular space

Dog

- It is small and situated almost entirely in the thoracic cavity
- The left lobe is larger than the right

Rabbit

- As in ox

Fowl

- The thymus is well developed in young chicks; the lobules are extending along the neck on either side

MODULE-15: ENDOCRINE SYSTEM

Learning objectives

- To get to know about the ductless wonders and key players in the body - endocrine glands in various species - locative anatomy and topographical anatomy

THYROID GLAND - OX

- The thyroid gland is a very vascular ductless gland, soft and dark red in colour. It is situated on the cranial part of trachea
- It consists of two lateral lobes and a connecting isthmus
- The lateral lobes are irregularly triangular in outline and are flattened
- They are situated on the lateral aspects of the first one or two tracheal rings
- The *superficial face* is related to the sternothyrohyoideus, sternocephalicus, common carotid artery, internal jugular vein, vagus and sympathetic nerves
- The *deep face* is related to the trachea
- The *cranial pole* is narrow
- The *isthmus* is band like and connects the caudal ends of the lateral lobes and extends around the ventral face of the first tracheal ring.
- The weight is about 14 to 15 gm

THYROID GLAND - SPECIES DIFFERENCE

Sheep and Goat

- Lateral lobes have a long elliptical outline and lie on the each side of the 5^{th} or 6^{th} ring of the trachea
- They are connected by a flat glandular isthmus
- Accessory thyroids may be seen near the caudal extremity of the lateral lobes of thyroid

Horse

- Firmer in texture
- Lateral lobes are rounded; the average weight is about 15 gm.
- The cranial pole is large
- The isthmus is extremely fine

Dog

- The lateral lobes are long, narrow and flattened and are situated along the lateral face of the trachea from the larynx to the 6^{th} or 7^{th} tracheal ring
- Caudal pole is pointed
- The isthmus is inconstant

Rabbit

- They are relatively small

Fowl

- The thyroid gland consists of two oval bodies situated at the root of the neck on each side of trachea and oesophagus in relation to the common carotid artery just cranial to the branching off the brachial artery
- They are deep red in colour
- Large and the lateral lobes are triangular in outline
- They are united ventrally so that an isthmus cannot be distinguished

PARATHYROID GLAND - SPECIES DIFFERENCE

Ox

- The parathyroid are small glandular bodies
- They are four in number, two on either side
- The cranial pair occurs near the occipital artery
- The caudal pair is located in close association with the lateral lobes of thyroid gland

Species difference

Sheep and Goat

- Occur near the caudal extremity or on the deep surface of the lateral lobes of thyroid

Horse

- There is one parathyroid gland on each side in close relation to the lateral lobe of thyroid gland

Pig

- They are two on either side

Dog

- The parathyroid two on either side are on the deep face of the gland

Rabbit

- As in dog

Fowl

- They are two in number, one on either side embedded in the areolar tissue at the base of the thyroid; they are small spherical yellowish-white bodies

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ADRENAL GLAND - OX

- The adrenals are two small, flattened, reddish brown, ductless glands situated in the roof of the abdomen
- They are elongated from before backwards and flattened from side to side
- The right adrenal lies against the medial part of the cranial pole of the right kidney
- The medial face is flattened and applied against the right crus of the diaphragm
- The lateral surface lies in the renal impression of the liver
- The ventral surface is grooved for the passage of the caudal venacava
- The base is concave and rests against the cranial end of the right kidney
- The apex fits into the angle between the dorsal border of liver and the caudal venacava
- The left adrenal is flattened
- The right surface is related to the caudal venacava and left surface to the rumen
- The caudal border is deeply notched. It does not migrate with the left kidney

ADRENAL GLAND - SPECIES DIFFERENCE

Sheep and Goat

- Both the adrenals are bean shaped
- The right surface one lies along the medial border of the kidney
- The left surface one is longer and somewhat bent
- It is not in contact with the kidney from which it may be separated by 2 inches

Horse

- They are flattened bodies lying in contact with the cranial parts of the medial borders of the kidneys

Pig

- Long and narrow
- Each lies along the medial border of the corresponding kidney from the hilus forward

Dog

- The right adrenal is prismatic and pointed at either end
- It is placed between the cranial part of the medial border of the right kidney and the caudal vena cava
- The left adrenal is elongated and located along the abdominal aorta

Rabbit

- The paired adrenals are located cranial and medial to the kidneys and appear flattened against the dorsal body wall

Fowl

- They are small bodies about the size of a pea and lie against the medial part of the ranial ends of kidneys