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VISCERA

of domestic animals

Textbook for students
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CONTENT

GENERAL SPLANCHNOLOGY

The **internal organs** (splanchna, s. viscera) are a complex of the organs, which are:

- located in the cavity of the visceral tube, or are associated with it
- communicated with the external environment of the natural holes
  They also provide the metabolism in the body.

Visceral tube is presented by:

- facial part of the head
- neck visceral space
- thoracic cavity
- abdominal cavity
- pelvic cavity

The **viscera** include:

1. The **digestive** apparatus – *apparatus digestorius*
2. The **respiratory** apparatus – *apparatus respiratorius*
3. The **urinary** apparatus – *apparatus uropoeticus*
4. The **genital** apparatus – *apparatus genitalis*

The internal organs are similar in structure. They are divided into two types:

- **tube-shaped** (have cavity and wall)
- **compact**, or **parenchimatous** (have parenchyma and stroma)

Patterns of the tubular organs structure

Tubular, or tube-shaped organs in the body are pathways for certain substances such as air, feed, urine, sperm. So they have the form of channel or tube that has **wall** and **cavity**.

1. The wall of the tubular organ has **three tunics**:

A. The inner tunic is a **mucosa** (tunica mucosa). It consists of epithelial layers and submucosal basis. The epithelial layer of the mucous membrane is represented by a different type of epithelium, depending on the function of the organ.

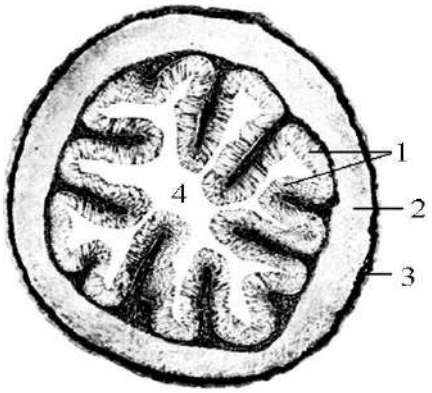
B. The middle tunic is **muscular** (tunica muscularis). It is a striated or unstriated muscle tissue. The middle tunic consists of striated muscle in initial part of the visceral tube (esophagus, pharynx, larynx) and in its final part (anus, urethra). The unstriated muscle forms the middle tunic of the wall of the organs that are located in the thoracic, abdominal and pelvic cavities.

In the muscular tunic two layers are distinguished:

- ***longitudinal*** (stratum longitudinale) is a superficial, adjacent to serous tunic
- ***circular*** (stratum circulare) is a deep, adjacent to the mucosa

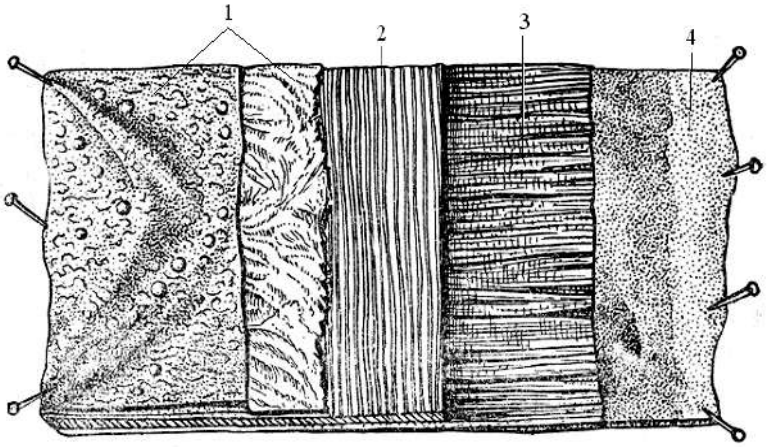
The muscular membrane provides a peristalsis (movement), which results in the movement of the contents (feed, urine), or it closes openings (sphincter).

The middle tunic of the tubular organs can be cartilaginous (larynx, trachea, bronchi), or osseous (the nose).



Transverse section of the gut wall

1 – mucous tunic
2 – muscular tunic
3 – serous tunic
4 – cavity of gut



Longitudinal section of the gut wall

1 – mucous tunic
2 – circular layer of muscular tunic
3 – longitudinal layer of muscular tunic
4 – serous tunic

C. The **outer tunic** may be represented by **adventitia** or **serosa**:

- *tunica adventitia* is an outer tunic of organs lying outside the serous cavities
- *tunica serosa* covers the organs that is located in the serous cavity. The serous membrane in the thoracic cavity is called *pleura*, and in the abdominal and 1-st half of pelvic cavities – *peritoneum*.

2. The intramural and **extramural glands** are connected with the wall of the tube-shaped organ For example, salivary, gastric, intestinal glands, liver, pancreas are associated with the digestive tube.

3. The mucosa of the tube-shaped organ consists of **lymphoreticular tissue**. It may be a single lymphatic nodes or lymphatic aggregate or tonsils. These structures perform a protective function.

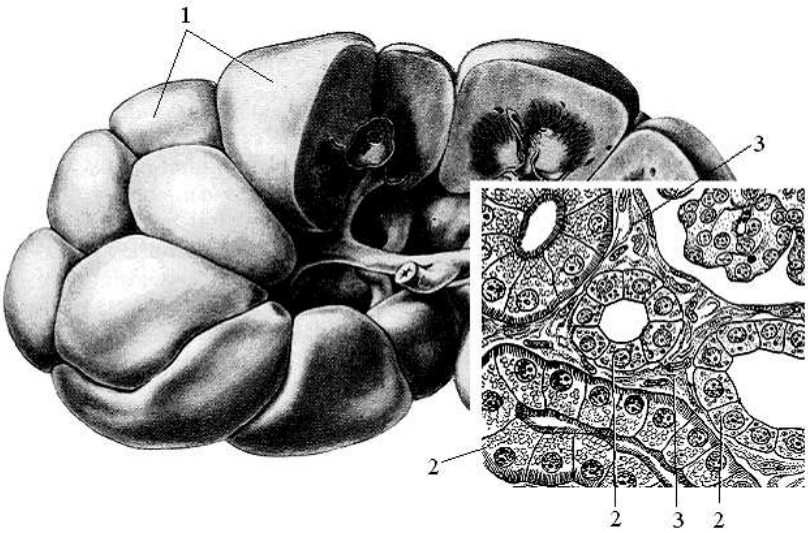
4. The blood and lymphatic **vessels** and **nerves** are branched in the wall of the tubular organs.

Patterns of compact organs structure

Compact organs have **parenchyma** and **stroma. Parenchyma** is a main specific tissue, which determines the function of organ.

Stroma is a connective tissue that provides definite form of the organ; it divides the organ into functional units (lobes, particles, segments). Stroma creates conditions for the work of parenchyma.

The excretory ducts of the glands, blood and lymph vessels, and nerves pass through the stroma. Stroma provides the reparative ability of organ (to regenerate and restore).



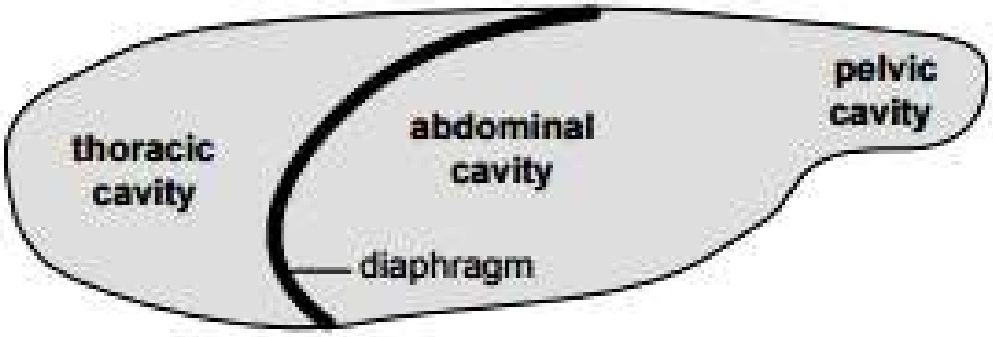
Parenchymatous organ (kidney of cattle)

1 – kidney particles
2 – parenchyma (elements of the nephron)
3 – stroma (connective tissue)

SEROUS MEMBRANES and CAVITIES

Body Cavities

To get a clear picture of the organs and to understand how the organs function, first of all it is necessary to know the morphology of the thoracic, abdomen and pelvic cavities and their lining membranes.



The major cavities of the body are within the trunk. They contain viscera and serous membrane cavities.

Thoracic cavity is lined by endothoracic fascia.

Abdominal and pelvic cavities are lined by transversal fascia.

Serous membrane cavities are lined by serous membrane. It functions to prevent adhesions of organs, thereby allowing organs to move freely relative to one another.

A serous membrane consists of a single layer of flattened mesothelial cells applied to the surface of a thin layer of collagenous tissue that is attached to underlying endothoracic/transversal fascia.

The mesothelium of the serous membrane forms the lining of a closed serous membrane cavity.

Serous membrane lining the wall of a serous cavity is designated as **parietal**, while serous membrane covering viscera is called as **visceral**. Connecting serous membrane pass between parietal and visceral components.

The serous membranes are the following:

Pleura is the serous membrane which covers the lungs, lines the walls of the thoracic cavity, and covers the structures in the mediastinum.

Peritoneum is the serous membranes which cover the viscera located in the abdominal cavity, it lines the walls of the abdominal cavity. The peritoneal cavity is found within the abdominal and pelvic cavities of the body.

THORACIC CAVITY AND PLEURAE

THORACIC CAVITY

The **thoracic cavity** (cavum thoracis) is formed by the muscles, bones, and ligaments of the thoracic wall.

The thoracic wall is formed bilaterally by the ribs and the intercostal muscles, and dorsally by the bodies of the thoracic vertebrae and the intervening fibrocartilages.

Ventrally, the sternum and the paired flat transversalthoracic muscles contribute to the thoracic wall. Caudally, the base of the thoracic cavity is formed by diaphragm.

The endothoracic fascia (fascia endothoracica) is the areolar tissue which attaches the costal and diaphragmatic pleurae to the underlying muscles, ligaments, and bone. The endothoracic fascia attaches the costal pleura to the ribs.

The **thoracic inlet** (apertura thoracis [cranialis]) is the roughly oval opening into the cranial part of the thoracic cavity. It is bounded bilaterally by the first pair of ribs.

Mediastinum

The mediastinum is the space between the right and left pleural sacs which encloses the thymus, heart, aorta, trachea, esophagus, the vagus nerves, and other nerves and vessels. It is divided by the heart into three transverse divisions.

The portion of the mediastinum lying in front of the heart is known as the ***cranial mediastinal cavity*** (cavum mediastinale craniale). The portion containing the heart is called the ***middle mediastinal cavity*** (cavum mediastinale medium). The ***caudal mediastinal cavity*** (cavum mediastinale caudale) is that part of the mediastinum lying caudal to the heart. The thymus, trachea, and thoracic duct are located primarily in the cranial portion.

For purposes of description the mediastinum may also be divided into dorsal and ventral portions by a frontal plane passing through the roots of the lungs.

Pleurae

The ***pleurae*** are the serous membranes which cover the lungs, line the walls of the thoracic cavity, and cover the structures in the mediastinum, or in places form the mediastinum. The pleurae form two complete sacs, one on either side, which are known as the pleural cavities.

Pleura is two pleural cavities (separated by mediastinum) are found within the thoracic cavity.

Each **pleural cavity** (cavum pleurae) in life is essentially only a potential cavity, because it contains only a capillary film of fluid which moistens the flat mesothelial cells paving its surface.

Pericardium is the pericardial cavity is found within the mediastinum of the thoracic cavity.Visceral pericardium is also called epicardium.

The visceral pleura of the lungs, or ***pulmonary pleura***, lies in contact with the wall or ***parietal pleura***. Only when gas (air) or fluid collects between the visceral and parietal pleurae and prevents a lung from expanding does it exist as a real cavity.

The pleural cavities do not communicate with each other.

The **parietal pleura** (pleura parietalis) form the walls of the pleural cavities.

Parietal pleura is further subdivided into:

- costal pleura
- diaphragmatic pleura
- mediastinal pleura

The **costal pleura** (pleura costalis) is that portion of the pleura which attaches to the inner surfaces of the lateral walls of the thoracic cavity.

The **diaphragmatic pleura** (pleura diaphragmatica) is the pleural covering of the diaphragm.

The **mediastinal pleura** (pleura mediastinalis) is the pleural covering of the mediastinum.

Visceral pleura is also called ***pulmonary*** pleura.

The **pulmonary pleura** (pleura pulmonalis) tightly adheres to the surfaces of the lungs. It is the visceral portion of the pleura.

The pulmonary pleura is more tightly adherent to the lung parenchyma than is the parietal pleura to the thoracic wall.

ABDOMINAL CAVITY AND PERITONEUM

PERITONEUM

The **peritoneum** is a serous membrane (tunica serosa) which lining of the abdominal cavity and its coextensive pelvic and scrotal cavities, is made up of a

surface mesothelium composed of squamous cells, and a connective tissue ground work, or stroma.

Peritoneum is united with the transversal fascia.

The peritoneum serves to reduce friction between organs. A small amount of viscous fluid is produced for this purpose.

The peritoneum may be divided into:

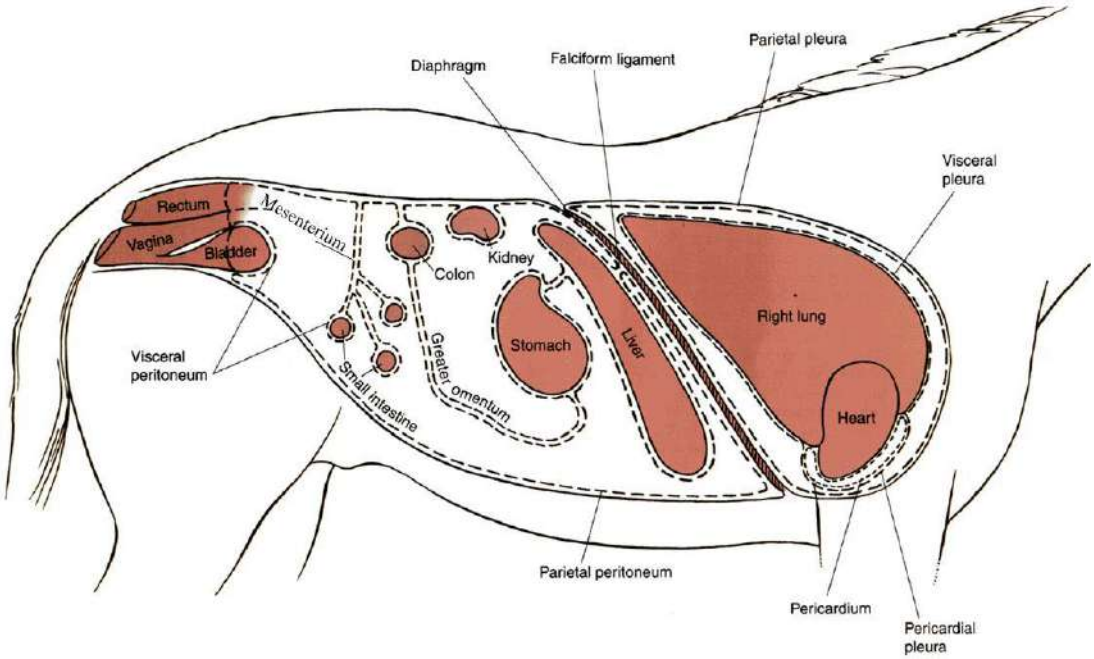
The **parietal peritoneum** (peritoneum parietale), which covers in large part the inner surface of the walls of the abdominal, pelvic, and scrotal cavities.

The **visceral peritoneum** (peritoneum viscerale), which covers the organs of the abdominal, pelvic, and scrotal cavities, wholly or in part.

The **connecting peritoneum**, which consists of double sheets of peritoneum extending between organs or connecting them to the parietal peritoneum.

Connecting peritoneum forms are:

- mesentery
- greater omentum
- lesser omentum
- ligament
- excavation
- vaginal tunics



Serous membrane of the thoracic, abdominal and pelvic cavities

A **mesentery** (mesenterium), in a restricted sense, passes from the abdominal wall to the intestine. A mesentery is any wide serous fold which attaches organs to a wall and serves as a route by which the nerves and vessels reach the organs.

The peritoneal folds which, in the adult, leave approximately the greater and lesser curvatures of the stomach are known as the **greater** and the **lesser omentum**, respectively. The **lesser omentum** extends between the liver and the lesser curvature of the stomach and the duodenum. An **omentum** passes from the stomach to other organs or to a wall.

The **greater omentum**, a fat-streaked, lacy, double reflection of peritoneum, covers most of the abdominal contents ventrally and on the sides. It lies principally between the parietal peritoneum and the intestinal mass. The greatest caudal extension of the liver occupies the right hypochondriac region.

A **ligament** passes from a wall to an organ, or from an organ to an organ, and is usually narrow.

A vaginal tunicis the cavity of the vaginal process begins at the vaginal ring and extends into thescrotum around the spermatic cord and testis (connecting vaginal tunic forms: mesorchium and mesoductus deferens)

PELVIC PERITONEAL EXCAVATIONS

The caudal extension of the peritoneum into the pelvic cavity is named **excavation**.

*Excavations of the female **are 4**:*

- pararectal fossa (fossa pararectalis)
- rectogenital excavation (excavatio rectogenitalis)
- vesicogenital excavation (excavatio vesicogenitalis)
- pubovesical excavation (excavatio pubovesicalis)

*Excavations of the male **are 3**:*

- pararectal fossa (fossa pararectalis)
- rectovesical excavation (excavatio rectovesicalis)
- pubovesical excavation (excavatio pubovesicalis)

The **cavities** enclosed by serous membrane are closed cavities.

Organs which lie against the walls of the abdominal or pelvic cavities and which are covered only on one surface by peritoneum are said to be **retroperitoneal**.

Organs which project freely into the abdominal, pelvic, and scrotal cavities and receive a nearly complete covering of peritoneum are termed **intraperitoneal**.

ABDOMINAL CAVITY

The **abdominal cavity** (*cavum abdominis*) is that part of the trunk which extends from the diaphragm to the pelvis. It contains the largest cavity in the body. Caudally, the abdominal cavity is continuous with the pelvic cavity. The abdominal cavity is a muscle- and bone-bounded cavity. It is lined internally by the transversal fascia, which in turn is covered by the peritoneum.

The abdominal cavity contains the abdominal viscera, which include primarily the flexuous alimentary canal and its two associated, indispensable glands, the liver and the pancreas.

It is bounded:

- ***cranially*** by the diaphragm

- ***dorsally*** by the back and lumbar
- ***bilaterally*** by the lateral costal and abdominal walls
- ***ventrally*** by the ventral abdominal wall

There are three unpaired apertures in the diaphragm: the esophageal hiatus, for passage of the esophagus, vagal nerve trunks, and esophageal vessels; the postcaval foramen, for passage of the postcava; and the aortic hiatus, for passage of the aorta, lumbar cistern, and the azygos and hemiazygos veins.

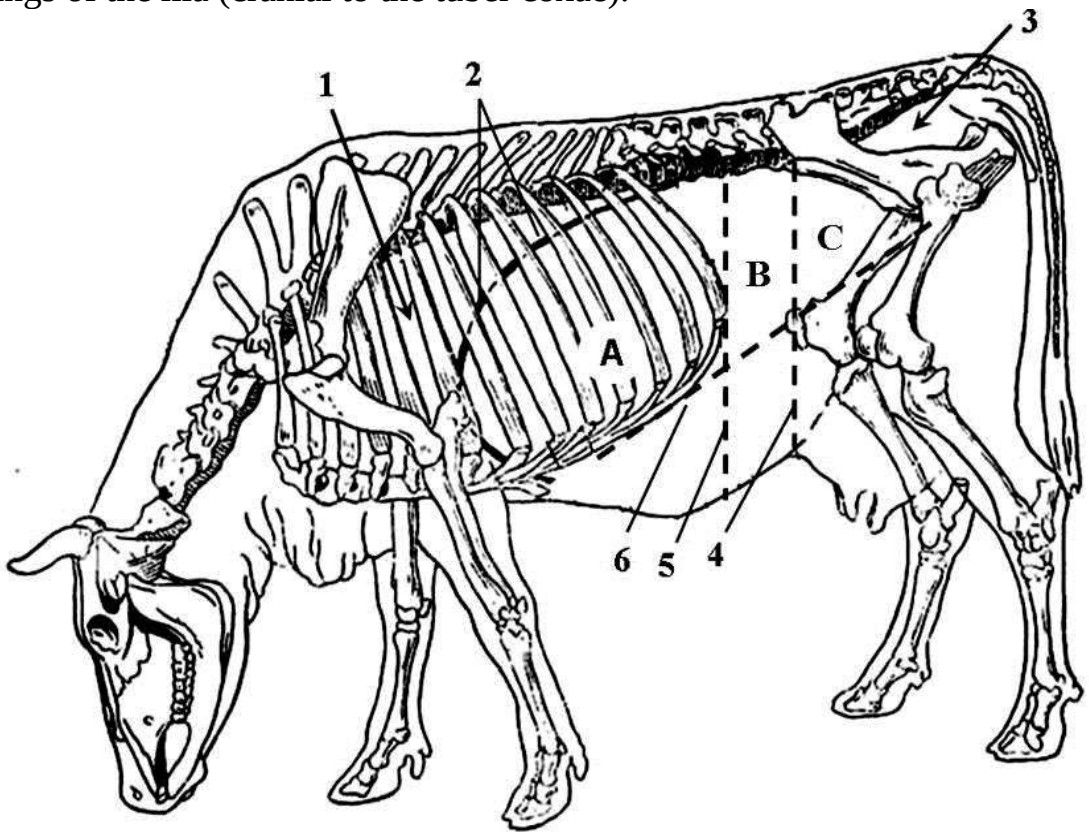
Caudally, the abdominal cavity communicates freely with the pelvic cavity at the pelvic inlet.

SEGMENTS AND REGIONS OF ABDOMINAL CAVITY

For convenience of description the abdominal cavity is divided into three parts (segments) and nine regions by four imaginary planes.

The **I s e g m e n t a l p l a n e** passes through the most caudal border of the costal arch.

The **II s e g m e n t a l p l a n e** passes through the most cranial parts of the wings of the ilia (cranial to the tuber coxae).



Division of the abdominal cavity on the segment
A – epigastric, B – mesogastric, C – hypogastric
1 – thoracic cavity, 2 – diaphragm, 3 – pelvic cavity,
4 – II segmental plane, 5 – I segmental plane, 6 – frontal plane.

By means of these two planes the abdomen is divided into three segments which are named, from before backward, the **epigastric *(epigastrium)***, **mesogastric *(mesogastrium)***, and **hypogastric *(hypogastrium)*** segments. Of these three segments, the epigastric is by far the largest. The hypogastric segment is smallest, as it ends caudally at the pelvic inlet.

Each segment is divided into three regions.

F r o n t a l p l a n e passes through the cartilaginous part of the rib arch to the hip joint.

M i d d l e s a g g i t a l (м e d i a n) p l a n e descends from the axis of the body until it stops in the frontal plane.

These imaginary planes divide the abdomen into the nine regions.

Three regions of the **epigastric segment** are:

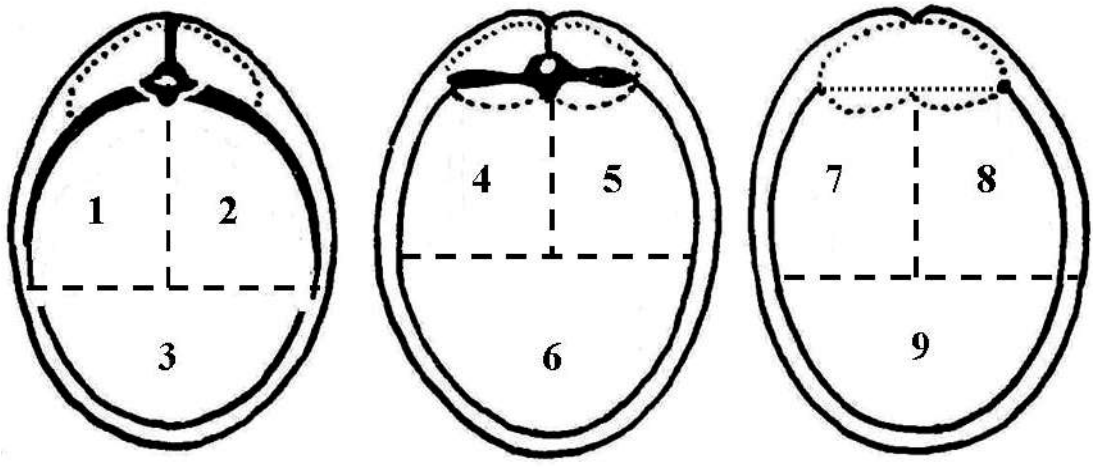
1. **right hypochondriac region** – *regio hypochondriaca dextra*
2. **left hypochondriac region** –*regio hypochondriaca sinistra*
3. **xiphoid region** – *regio xiphoidea*

Three regions of the **mesogastric segment** are:

4. **left iliac region** – *regio iliaca sinistra*
5. **right iliac region** – *regio iliaca dextra*
6. **umbilical region** – *regio umbilicalis*

Three regions of the **hypogastric segment** are:

7. **left inguinal region** – *regio inguinalis sinistra*
8. **right inguinal region** – *regio inguinalisdextra*
9. **pubic region**– *regio pubis*



epigastrium mesogastrium hypogastrium

Regions of the abdominal cavity at level of the epigastric, mesogastric and hypogastric segment, respectively.

Each region of the abdominal cavity has six walls including three or four arbitrary plane.

PELVIC CAVITY

The **pelvic cavity** (*cavum pelvis)* begins at the pelvic inlet as a continuation of the abdominal cavity.

It is bounded ***dorsally*** by the sacrum and first coccygeal vertebra; ***bilaterally***, it is bounded in front by the ilia and behind these by the coccygeus, and gluteal muscles. It ends at the pelvic outlet, which is bounded by the first coccygeal vertebra ***dorsally***, the gluteal muscles ***bilaterally***, and the ischial arch ventrally. The ***floor*** is formed mainly by the pubes and ischii. The pelvic cavity contains the rectum and the urethra in both sexes, the vagina and part of the vestibule in the female, and a part or all of the prostate in the male.

The abdominal and pelvic cavities are lined by fascia.

A STUDENT SHOULD UNDERSTAND THE NEXT FACTS WHEN STUDYING THE VISCERA:

- anatomical composition of the viscera of each apparatus, to identify organs in study and museum anatomical specimens, to indicate their function
- the anatomical structure of the organ, the topography of this organ in the body, species and age characteristics

A STUDENT SHOULD BE ABLE TO:

- to show structural details of organs on anatomical preparation

THE DIGESTIVE APPARATUS
APPARATUS DIGESTORIUS

The **digestive apparatus** *(apparatus digestorius),* consists of the digestive tube and accessory organs.

That portion caudal to the pharynx, including all structures from the esophagus to the anus, is termed the alimentary canal (canalis alimentarius).

The digestive apparatus is divided into four divisions or intestine:

- ***HEADGUT***
- ***FOREGUT***
- ***MIDGUT***
- ***HINDGUT***

ANATOMICAL COMPOSITION
OF DIGESTIVE APPARATUS

I.ORGANS OF THE HEADGUT*:*

1. **The oral cavity organs**–*organa cavum oris*:
   - **lips** – *labia oris*
   - **cheeks** – *buccae*
   - **teeth** – *dentes, s. odus*
   - **gums** – *gingivae*
   - **hard palate** – *palatum durum*
   - **soft palate** – *palatum molle, s. velum palatinum*
   - **tongue** – *lingua, s. glossa*
   - **salivary glands** – *glandulae salivales*

2.Pharynx – pharynx
- **tonsils** – *tonsillae*

II.ORGANS OF THE FOREGUT:

1. Esophagus – *esophagus*
2. Stomach – *gaster, s. venter, s. stomachus*

II.ORGANS OF THE MIDGUT:

1.Small intestine– *intestinum tenue:*
- **duodenum** – *duodenum*
- **jejunum** – *jejunum*
- **ileum** –*ileum*

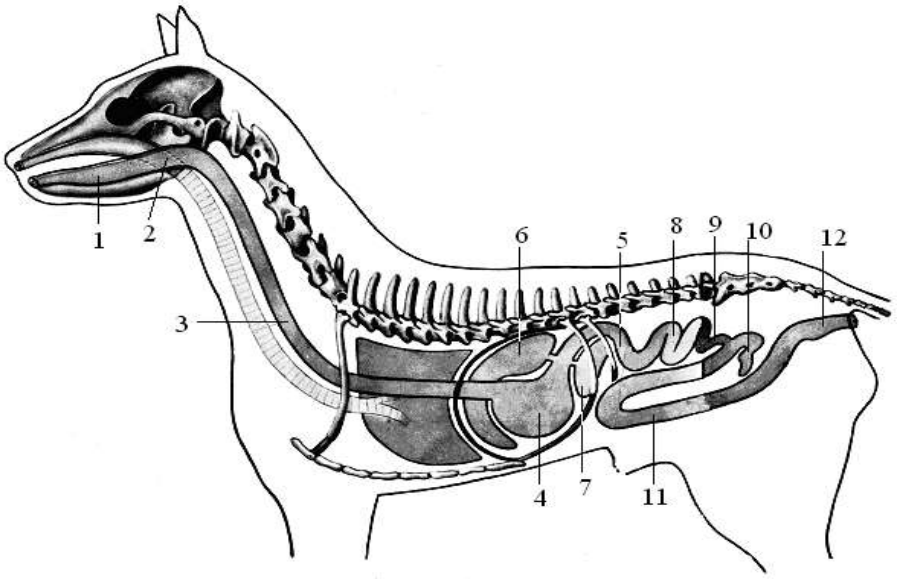
2. Extramural digestive gland:
- **liver** –*hepar*
- **pancreas** –*pancreas*

IV. ORGANS OF THE HINDGUT:

Large intestine – *intestinum crassum*:
- **cecum** –*caecum, s. typhlon*
- **colon** – *colon*
- **rectum** –*rectum, s. proctos*

The wall of the digestive tube is richly supplied with secretory epithelium and intrinsic glands. It is lined throughout by a mucous membrane (tunica mucosa) which is continuous with the surface integument at the mouth and anus.

HEADGUT



Digestive system of the dog

1 – mouth,
2 – pharynx,
3 – esophagus,
4 – stomach,
5 – duodenum,
6 – liver,
7 – pancreas,
8 – jejunum,
9 – ileum,
10 – cecum,
11 – colon,
12 – rectum.

MOUTH AND ASSOCIATED STRUCTURES

Mouth

The **mouth** (os), in a restricted sense, includes only the opening between the lips. In a broad sense it designates the oral cavity (cavum oris), in which are located the teeth and tongue. The oral cavity is divided into the vestibule and the oral cavity proper.

The **vestibule of the mouth** (vestibulum oris) is the space external to the teeth and gums and internal to the lips and cheeks. It opens to the outside anteriorly the oral fissure (rima oris), between the lips.

The parotid and zygomatic salivary ducts open into the dorsoposterior part of the vestibule. The parotid duct opens through the cheek on the small parotid papilla (papilla parotidea), located opposite the posterior part of the upper fourth premolartooth, approximately 5 mm. from the fornix of the vestibule, which is formed by a reflection of the mucosa from the cheek to the gum. The main duct of the zygomatic gland opens lateral to the posterior part of the upper first molar tooth on a small papilla near the vestibular fornix.

The **oral cavity proper** (cavum oris proprium) is bounded dorsally by the hard palate and a small part of the adjacent soft palate; laterally and anteriorly the dental arches and teeth form its boundary; the tongue and the reflected mucosa under it form the floor of this cavity. When the mouth is closed the tongue nearly fills the oral cavity proper. The sublingual and mandibular ducts open under the body of the tongue, on the inconspicuous sublingual caruncle (caruncula sublingualis).

Just posterior to the upper central incisor teeth is the incisive papilla (papilla incisiva), a rounded eminence which extends posteriorly to blend with the first transverse ridge formed of the mucosa covering the hard palate. The incisive canal, or nasopalatine duct (ductus nasopalatinus) opens on each side of this papilla.

The oral cavity is continuous posteriorly as the oral pharynx. The fauces is the border between them.

Lips

The **lips** (labia oris) form the anterior and most of the lateral boundaries of the vestibule. Upper and lower lips (labia maxillaria et mandibularia) are recognized, which meet at acute angles posteriorly, forming the commissures of the lip (commissurae labiorum). The lips bound the oral fissure, the external opening of the oral cavity.

The hair of both lips slopes postero-ventrally. It is thinner and shorter in front, longer and thicker farther back. A few of these are tactile hairs, or vibrissae. On the upper lip and adjacent dorsal part of the muzzle the vibrissae are imperfectly arranged in four rows.

The wide orbicularis oris muscle and the insertions of several other facial muscles form the media of the lips.

Cheeks

The **cheeks** (buccae) form the posterior portion of the lateral walls of the vestibular cavity. The morphology of the cheeks is closely reated to that of the lips, with which they are continuous. The lips and the cheeks consist of three basic layers. The **external layer** is the hairy integument; the **middle layer** consists of muscle and fibroelastic tissue; and the **inner layer** consists of the mucosa (tunica mucosa). The middle layer of the cheek consists primarily of the buccinator muscle. The mucosa of the lips and cheeks is thinly cornified stratified squamous epithelium which.

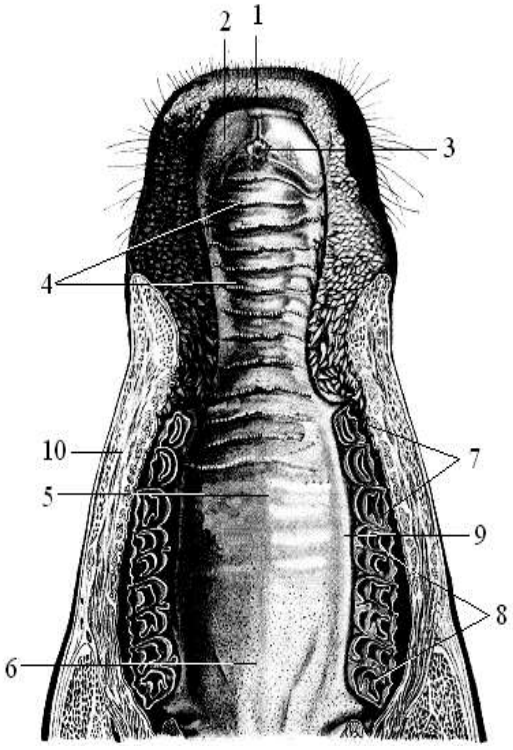
Palate

The **soft palate** (palatum molle) continues posteriorly from the hard palate. The soft palate is most long in the horse.

On each side the posterior border of the soft palate is continued to the dorsolateral wall of the palatopharyngeal arch (arcus palatopharyngeus).

The palatopharyngeal muscle (m. palatopharyngeus) and the mucosa which covers it form pillar.

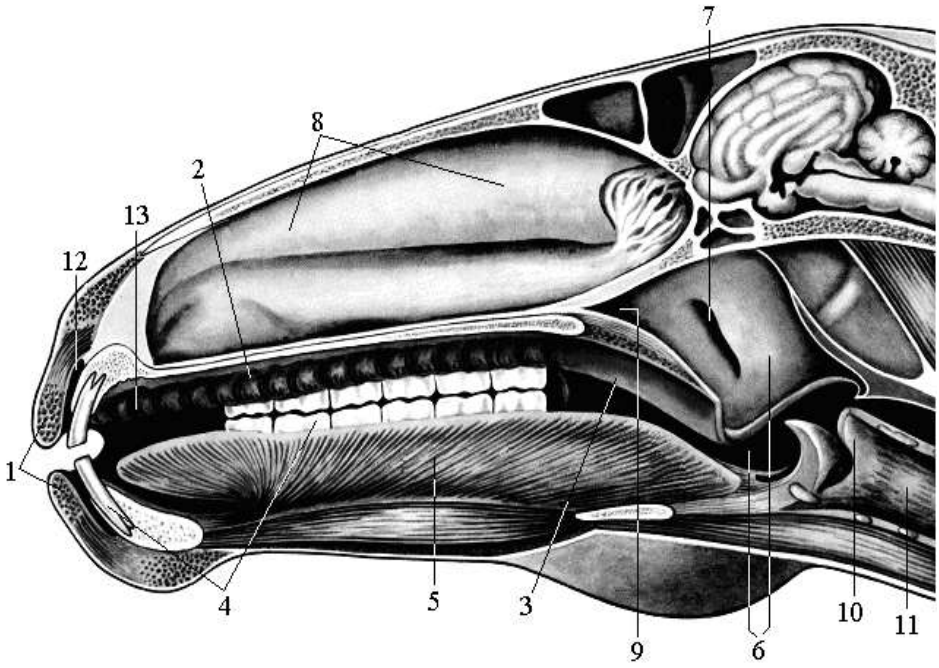
The **palate** (palatum) is a partly bony, partly membranous partition separating the respiratory and digestive passages of the head. The bony hard palate is in front, and the membranous soft palate behind.



The hard palate and soft palate of cattle

1 – upper lip
2 – cutting plate
3 – incisive papilla
4 – palatal rollers
5 – palatal suture
6 – soft palate
7 – upper premolars
8 – upper molars
9 – gum
10 – cheek

The **hard palate** (palatum durum) is formed by the palatine processes of the palatine, maxillary, and incisive bones on each side. The mucosa on the nasal side consists of pseudostratified ciliated columnar epithelium; that on the oral side consists of stratified squamous epithelium which is cornified. The hard palate is nearly flat. The portion of the soft palate posterior to a transverse plane through the posterior borders of the pterygoid bones is known as the **palatine veil** (velum palatini). The soft palate, from the ventral to the dorsal surface, consists of the following layered structures: stratified squamous epithelium, a continuation of that of the hard palate, covers the ventral surface of the soft palate.



The organs of oral cavity.**Sagittal section of the horse's head**

1 – lips, 2 – hard palate, 3 – soft palate, 4 – teeth, 5 – tongue, 6 – pharynx, 7 – auditive tubes (ostium), 8 – nasal cavity, 9 –choanae, 10 – larynx, 11 – trachea, 12 – vestibule of the mouth, 13 – oral cavity proper.

Teeth

The **teeth** (dentes) are highly specialized structures which serve as weapons of offense and defense, as well as for the procuring, cutting, and crushing of food.

Each tooth is divided into three parts. The **crown** (corona dentis) is the exposed part, the part which protrudes above the gums and is covered by the shiny white enamel. The **neck** (collum dentis) is a slight constriction of the tooth located at the gum line, where the enamel ends.

The **root** (radix dentis) is the portion below the gum, and for the most part it is embedded in the alveolus. Its pointed end is the apex of the root (apex radicis dentis). Many teeth have *more than one* root.

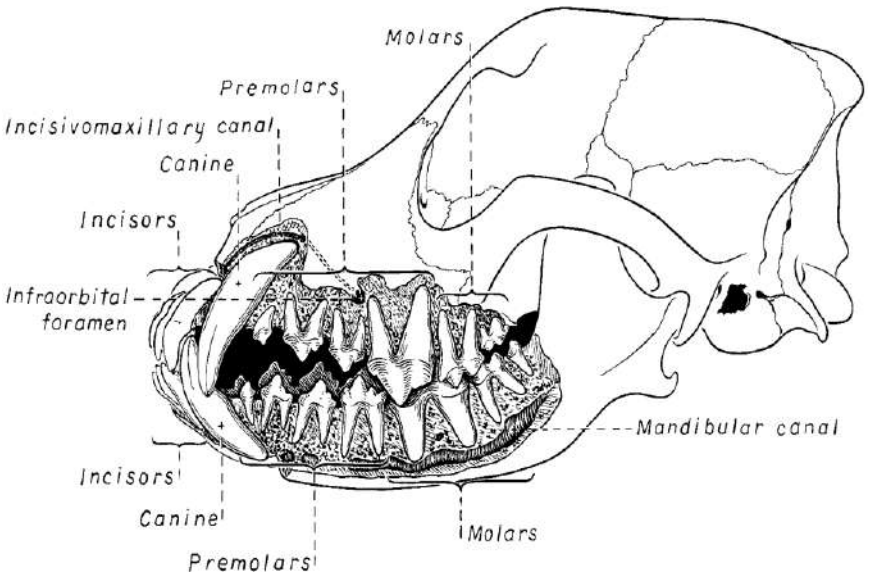
Once teeth are fully erupted in the dog they cease growing. Because of the increased use and greater dependence on the teeth which come about through growth, two sets of teeth are necessary. The first set is fully erupted and functional early in the second month after birth. These teeth, known as deciduous teeth (dentes decidui), serve the animal during its most active puppyhood. Upon approaching maturity, when

the jaws have become longer and larger and the small deciduous teeth are no longer adequate, they are shed and immediately replaced by the permanent teeth (dentes permanentes), which last throughout adult life. These are larger than the deciduous teeth.

The jaws continue to grow, so that additional permanent teeth are added in back of the **permanent premolar teeth**. These added teeth are the **true molars**. There are two on each side of the upper jaw, and three on each side of the lower jaw in the dogs

Teeth groupings.

The upper teeth are attached in the alveoli of the incisive (premaxillary) and maxillary bones. Those with roots embedded in the incisive bones are the **incisor teeth** (dentes incisivi). The upper incisors usually are placed slightly in front of the lower incisors.



The **canine teeth** (dentes canini) are separated from the comer incisors by an interdental space on the jaws. They are by far the longest teeth of the dog.

All teeth posterior to the canines are often referred to as the **cheek teeth**. They are divided into **premolars** and **molars**.

The molar teeth (dentes molares) **have no** deciduous predecessors.

Structure of teeth.

The dense, pearly-white outer layer of the crown is **enamel** (enamelum).

Dentin (dentinum), similar to bone in chemical composition, forms the bulk of the tooth, enclosing the pulp cavity internally and underlying the enamel externally. It is known as "ivory," and is yellowish white in color.

The **cementum** in the dog is a thin covering of bonelike tissue found only on the roots. Grossly, the cementum cannot be differentiated from the dentin which it covers. The **pulp** (pulpa dentis), the only soft tissue contained in a tooth, is composed of sensory nerves, arteries, veins, lymphatic capillaries. The pulp is contained in the pulp cavity (cavum dentis).

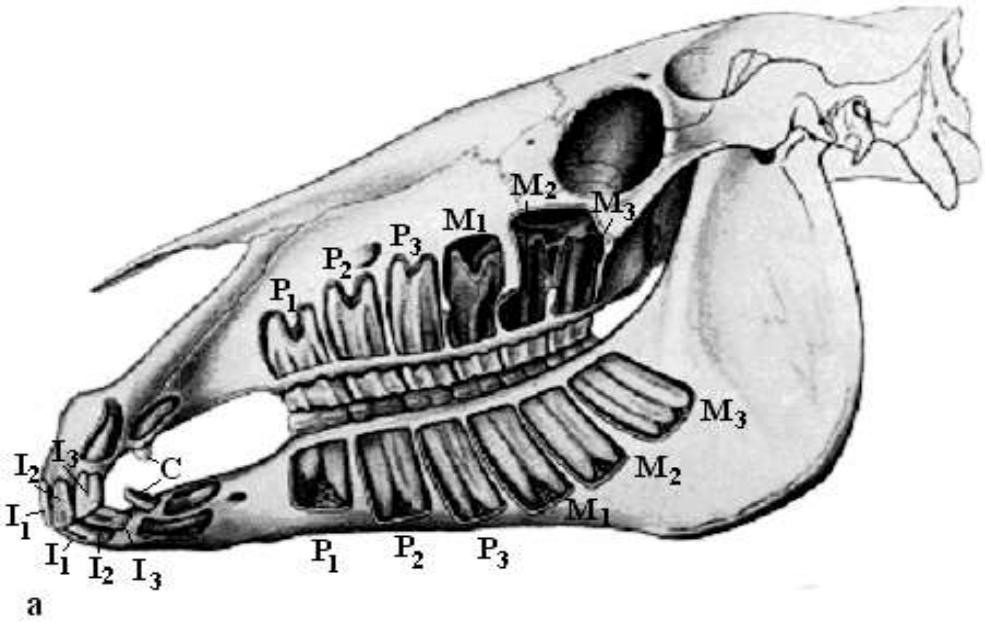
DENTAL FORMULAE

Since the teeth are grouped according to position and form, it is possible to express their arrangement as a ***dental formula***.

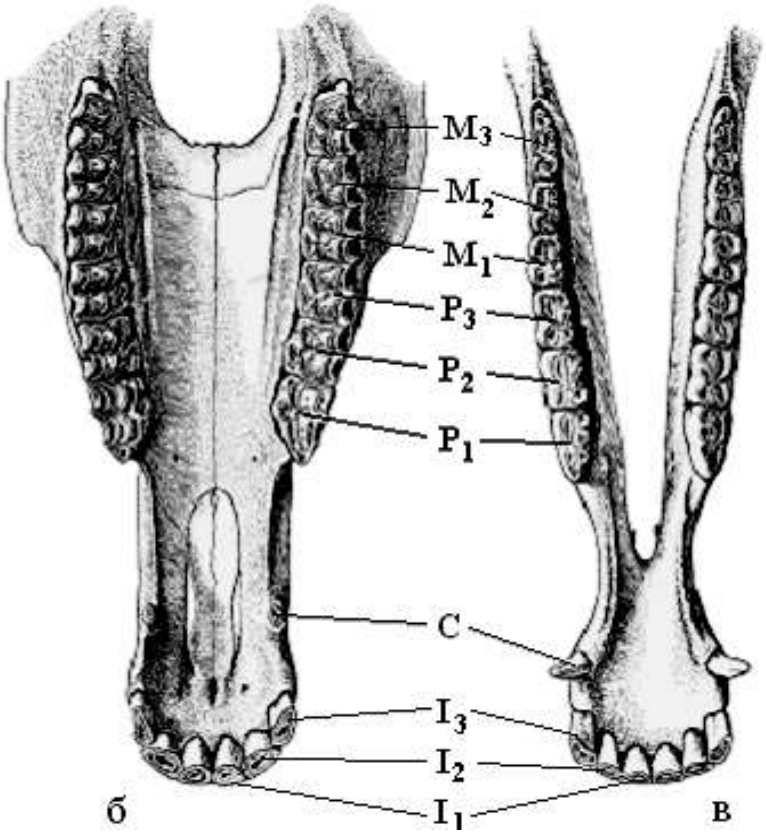
The abbreviation representing the particular teeth (**I**, incisor; **C**, canine; **PM**, premolar; **M**, molar) is followed by the number of such teeth on one side of the upper and the lower jaw.

Teeth of the horse

$$\textbf{Dd} = I\frac{3}{3}C\frac{1}{1}P\frac{3}{3}M\frac{0}{0} \qquad \textbf{Dp} = I\frac{3}{3}C\frac{1(0)}{1(0)}P\frac{3}{3}M\frac{3}{3}$$



а



б в

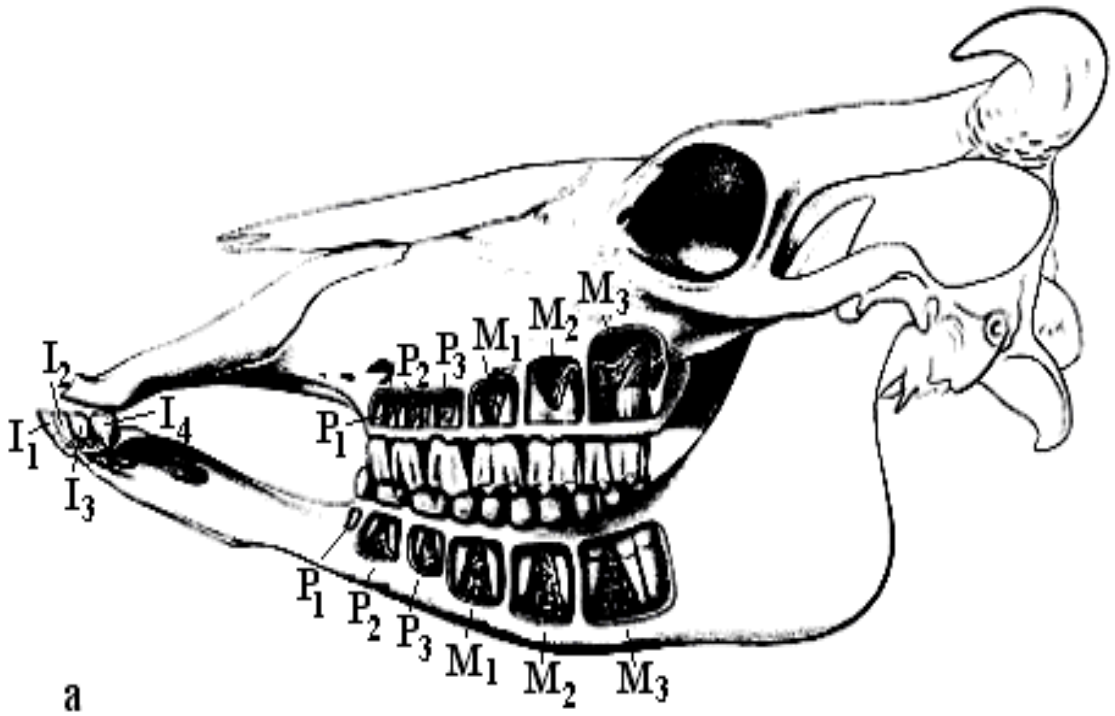
Teeth arches of the horse

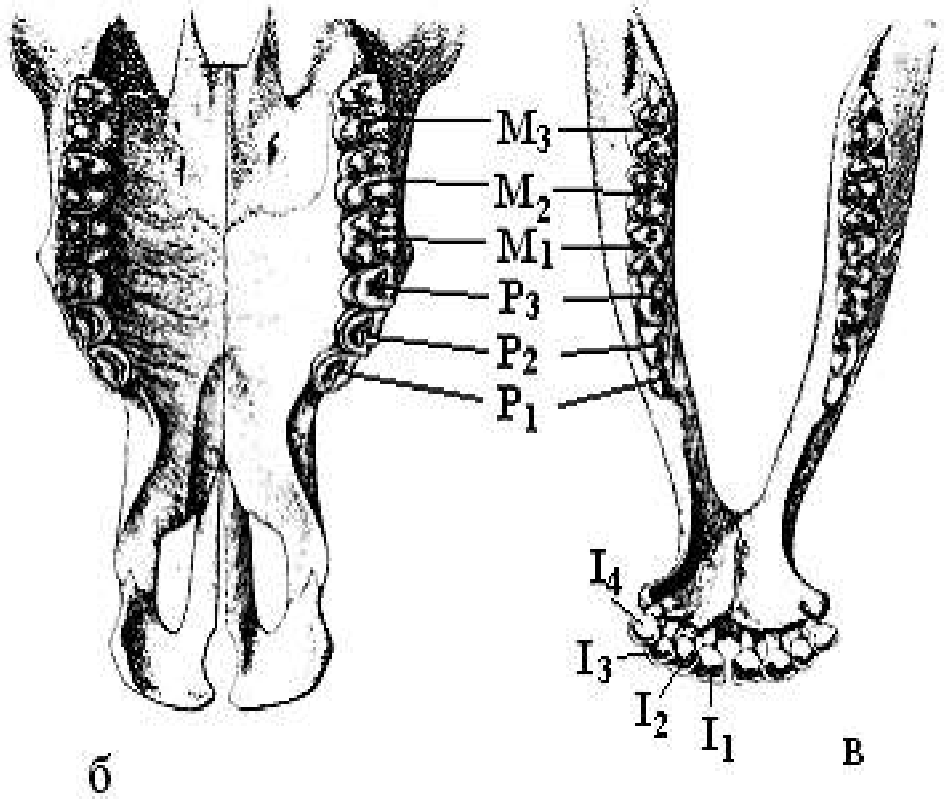
I – incisor
P – premolar
M – molar

б – teeth arch of the upper jaw
в – teeth arch of the lower jaw

Teeth of the cattle

Dd = $I\frac{0}{4}C\frac{0}{0}P\frac{3}{3}M\frac{0}{0}$ **Dp =** $I\frac{0}{4}C\frac{0}{0}P\frac{3}{3}M\frac{3}{3}$





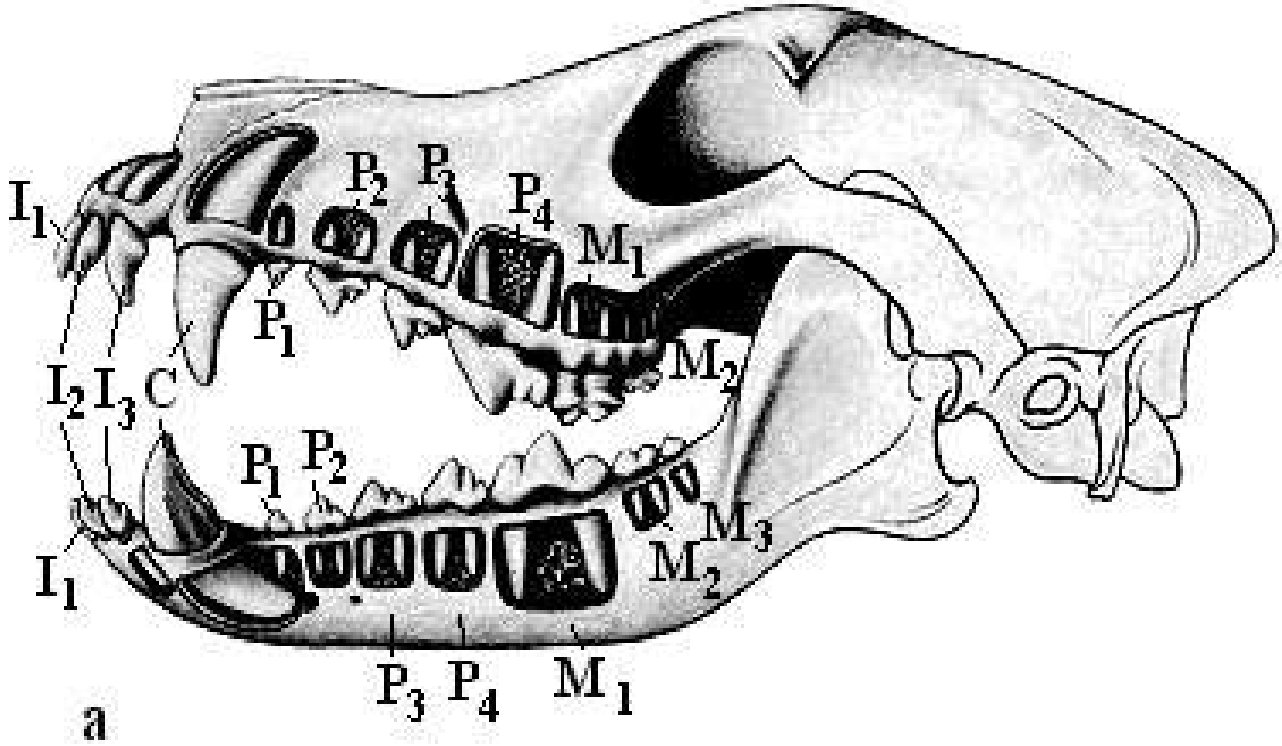
Teeth arches of the cattle

I – incisor
P – premolar
M – molar

а – teeth arch of the upper jaw
в – teeth arch of the lower jaw

Teeth of the dog

Dd = $I\frac{3}{3}C\frac{1}{1}P\frac{4}{4}M\frac{0}{0}$ **Dp =** $I\frac{3}{3}C\frac{1}{1}P\frac{4}{4}M\frac{2}{3}$



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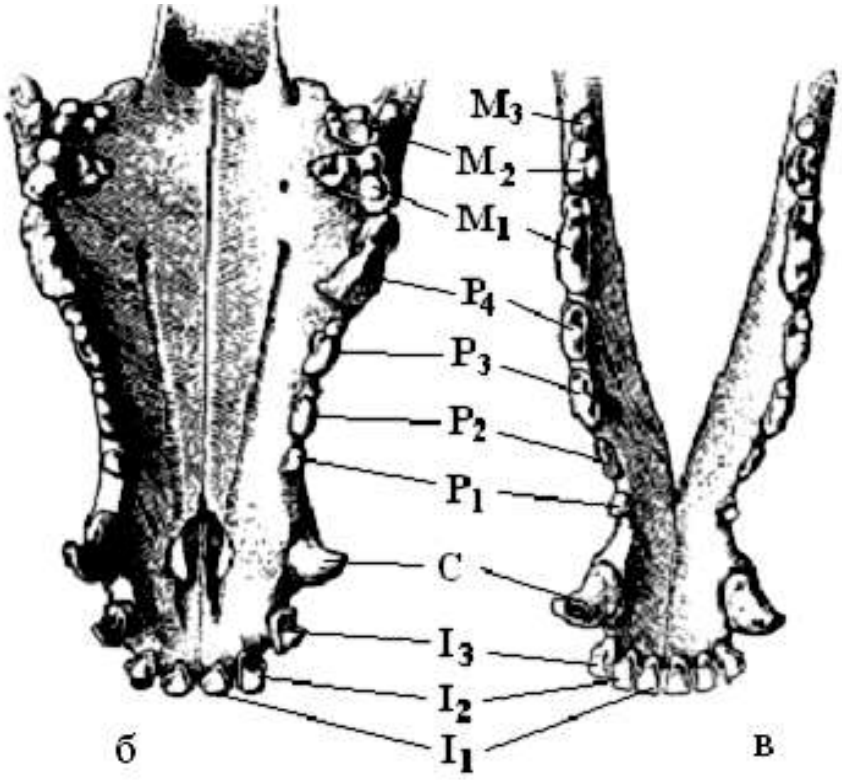


б в

Teeth arches (arcades) of the dog

I – incisor
P – premolar
M – molar

б – teeth arch of the upper jaw
в – teeth arch of the lower jaw

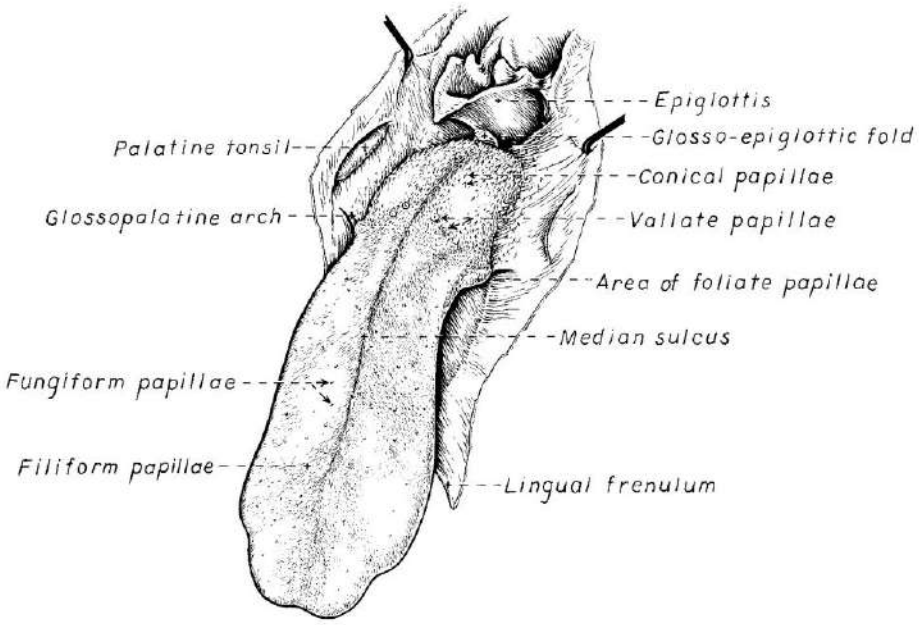
Gums

The **gums** (gingivae) are composed of dense fibrous tissue covered by smooth, heavily vascularized mucosae. It extends around the necks of the teeth and down into the alveoli to be continuous with the alveolar periosteum. The gums are continuous externally with the mucosa of the vestibule, and internally with that of the floor of the oral cavity proper or of the hard palate.

Tongue

The **tongue** (lingua) is a muscular organ which forms most of the floor of the mouth. It consists basically of a muscle fibers with a distinct dorsal longitudinal stratum and a surface mucosa.

The **dorsum** of the tongue (dorsum linguae) is nearly flat, both transversely and longitudinally. On the **root** or posterior part it becomes slightly rounded, particularly from side to side.



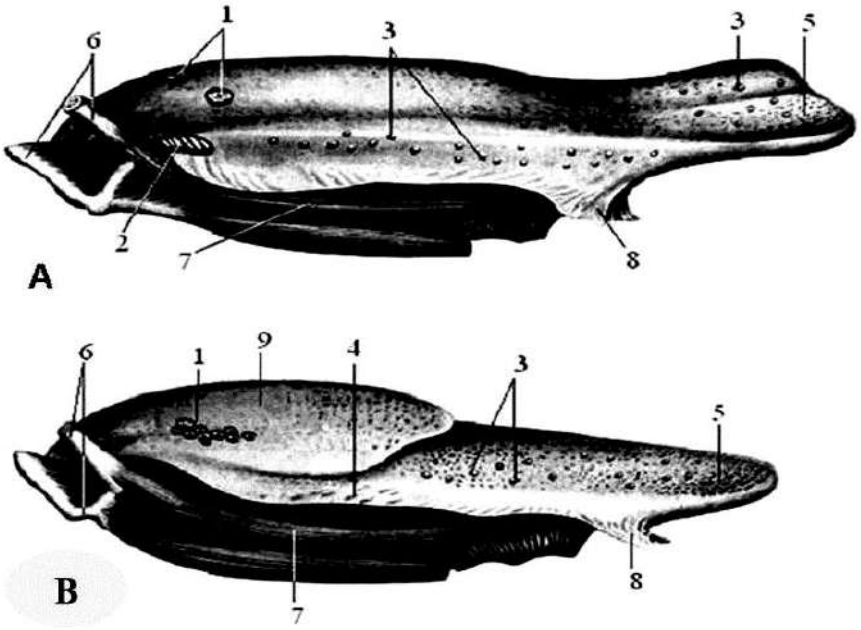
The tongue of the dog. Dorsal aspect.

The margin of the tongue (margo linguae), marking the junction of its dorsal and ventral surfaces, is thin at the apex (free end) but gradually thickens over the body. The **root** of the tongue (radix linguae) is the caudal third of the organ. The **body** of the tongue (corpus linguae) is the long part anterior to the root. The body ends anteriorly by becoming the **tip** or **apex** of the tongue (apex linguae), which is its highly mobile, free extremity.

An unpaired, ventral median fold of mucosa, the **lingual frenulum** (frenulum linguae), runs from the floor of the mouth mainly to the body of the tongue.

The **papillae of the tongue** (papillae linguales) are projections of the corium and lamina propria covered by stratified squamous epithelium. They are located on the dorsal surface and margins of the tongue.

Based on their shape, five types of papillae are recognized: filiform, fungiform, vallate, foliate, and conical.



The tongue
A – horse, B – cattle

1 – vallate papilla,
2 – foliate papilla,
3 – fungiform papilla,
4 – conical papilla,
5 – filiform papilla,
6 – hyoid bone,
7 – muscle of the tongue,
8 – frenulum,
9 – torus.

SALIVARY GLANDS

The **salivary glands**, are all of those glands which pour their secretions into the oral cavity. These are the parotid, mandibular, sublingual glands.

Parotid Gland

The **parotid gland** (glandula parotis) lies at the junction of the head and neck and closely embraces the basal portion of the auricular cartilage. Its outline is V-shaped as viewed from the surface.

The **parotid duct** (ductus parotideus) opens into the buccal cavity at the anterior end of a blunt ridge of mucosa by a small papilla. This is located opposite the fourth upper premolar.

Mandibular Gland

The **mandibular gland** (glandula mandibularis) is an ovoid body lying posterior to the angle of the jaw.

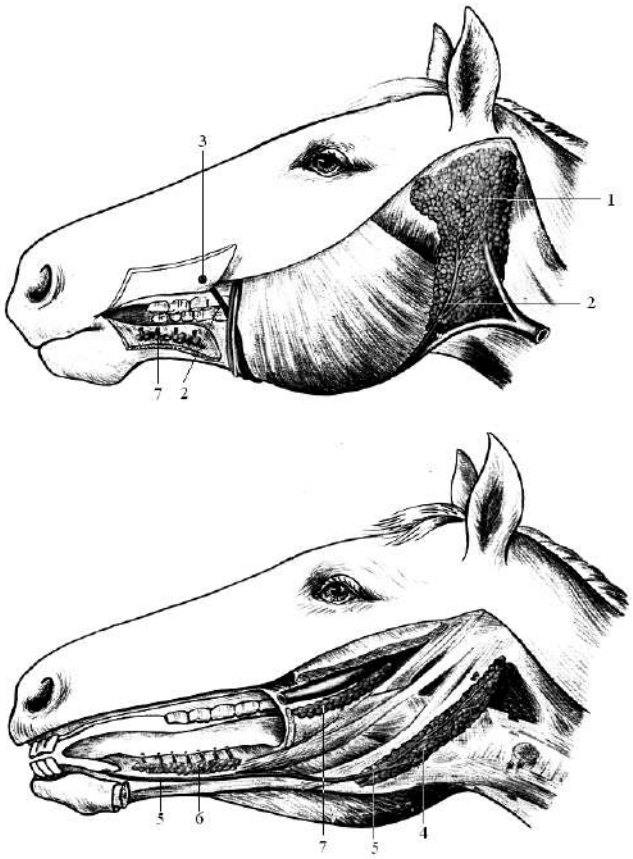
The **mandibular duct** (ductus mandibularis) leaves the medial surface of the gland near the ventromedial part of the impression formed by the sublingual gland. As the initial part of the duct rims anteromedially it lies in relation to the medial surface of the sublingual gland.

Sublingual Gland

The **sublingual gland** (glandula sublingualis) is the smallest of the salivary glands. The posterior surface of the gland is closely related to the mandibular gland. Both glands are enclosed in the same heavy, fibrous capsule.

The **sublingual duct** (ductus sublingualis) is closely related to the mandibular duct throughout its course in the intermandibular space, being located dorsal to it.

The ducts open on a small sublingual papilla (caruncula sublingualis), which is located lateral to the anterior end of the frenulum.



Salivary gland of horse

1 – parotid gland

2 – parotid duct

3 – salivary papilla

4– mandibular gland

5 – mandibular duct

6 – sublingual gland

7 – cheek gland

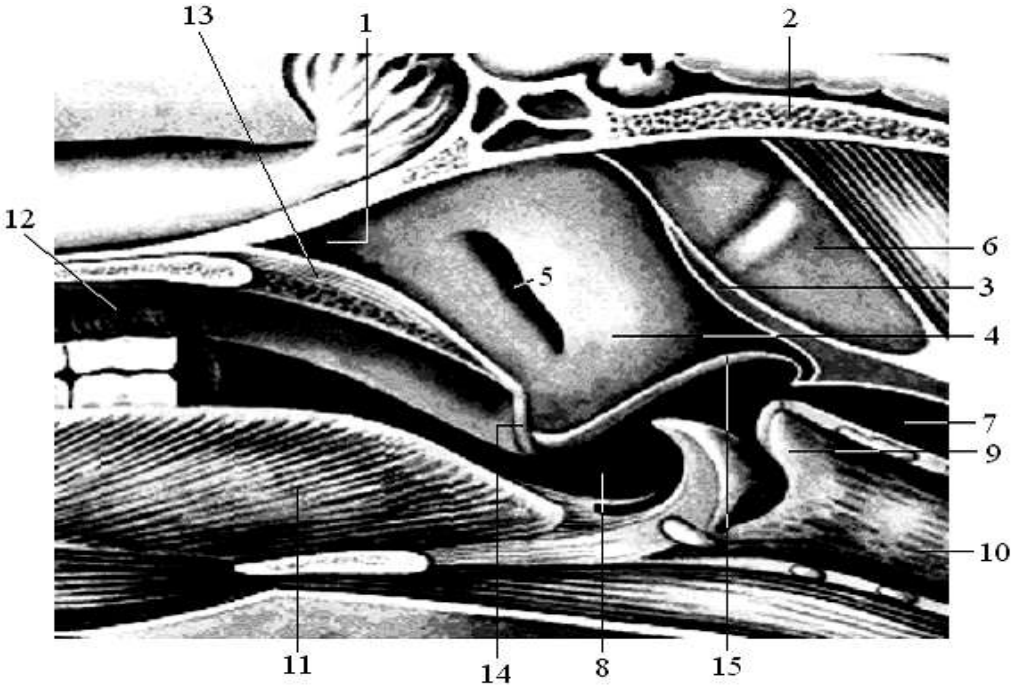
PHARYNX

The **pharynx** (cavum pharyngis) is a passage which is, in part, common to both the respiratory and the digestive system.

The anterior part of the pharynx is divided by the soft palate into an exclusivelyrespiratory, or dorsal, portion, and an alimentary and respiratory, or ventral, portion.

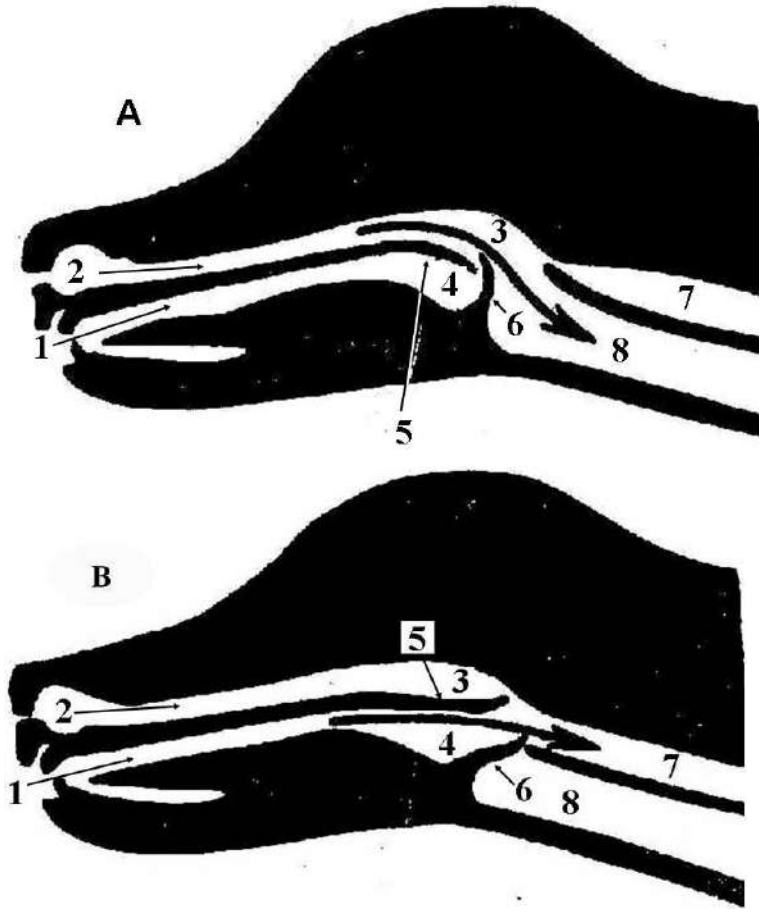
At the posterior end of the soft palate the two portions cross or become coextensive, forming the **pharyngeal isthmus** (isthmus pharyngeus). The isthmus is bounded posteriorly by the ventral surface of the epiglottis when the opening to the larynx is closed. When the laryngeal entrance is open the cavities of the pharynx and larynx are directly continuous.

Time-honored names for the anterior parts of the pharynx are: ***nasal part***, for the respiratory portion, and ***oral part***, for the digestive portion. Posterior to the pharyngeal isthmus the digestive tube is continued dorsal to the larynx as the laryngeal part of the pharynx, and the respiratory tube is continued ventrally as the larynxwhich in turn is continuous with the trachea.



Saggital section of the pharynx

1 – choanae; 2 – dorsal wall of pharynx; 3 – pharyngeal arch; 4 – nasal pharynx; 5 – auditory tube; 6 – pneumatic bag; 7 – esophagus, 8 – oral part of pharynx; 9 – larynx; 10 – trachea; 11 – root of tongue; 12 – hard palate; 13 – soft palate; 14 – palatal arch; 15 – pharyngoesophageal arch.



Pharynx

The position of the soft palate and the epiglottis:

- in time inhalation (A)
- in time deglutition (B)

1 – oral cavity
2 – nasal cavity
3 – nasal pharynx
4 – oral pharynx
5 – soft palate
6 – epiglottic cartilage
7 – esophagus,
8 – larynx

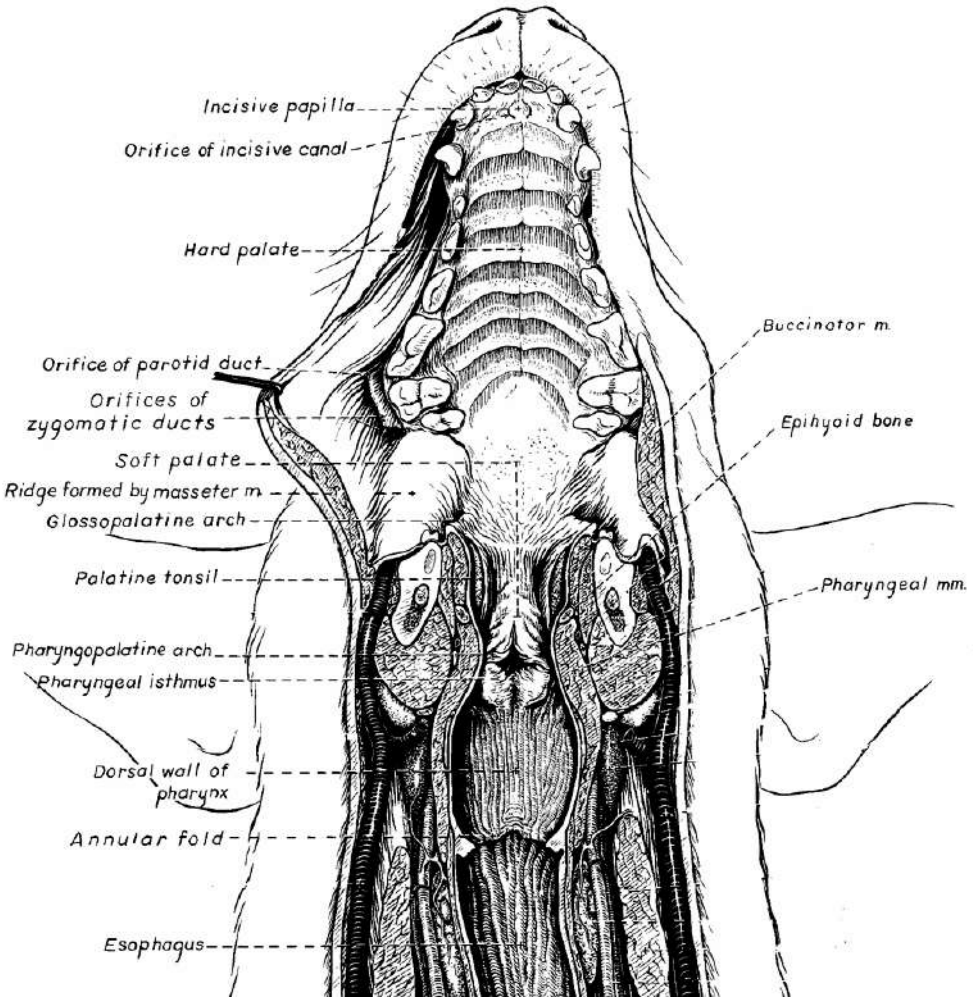
The **isthmus of the fauces** (isthmus faucium) is the short tubal connection between the oral cavity and the oral part of the pharynx. It is bounded on each side by the **palatoglossal arches**, ventrally by the **tongue**, and dorsally by the **soft palate**.

The **oral part** (pars oralis) of the pharynx extends from the isthmus of the fauces to the pharyngeal isthmus dorsally and to the larynx ventrally. It is bounded dorsally by the soft palate, ventrally by the root of the tongue, and laterally by the tonsillar sinus, with its contained palatine tonsil.

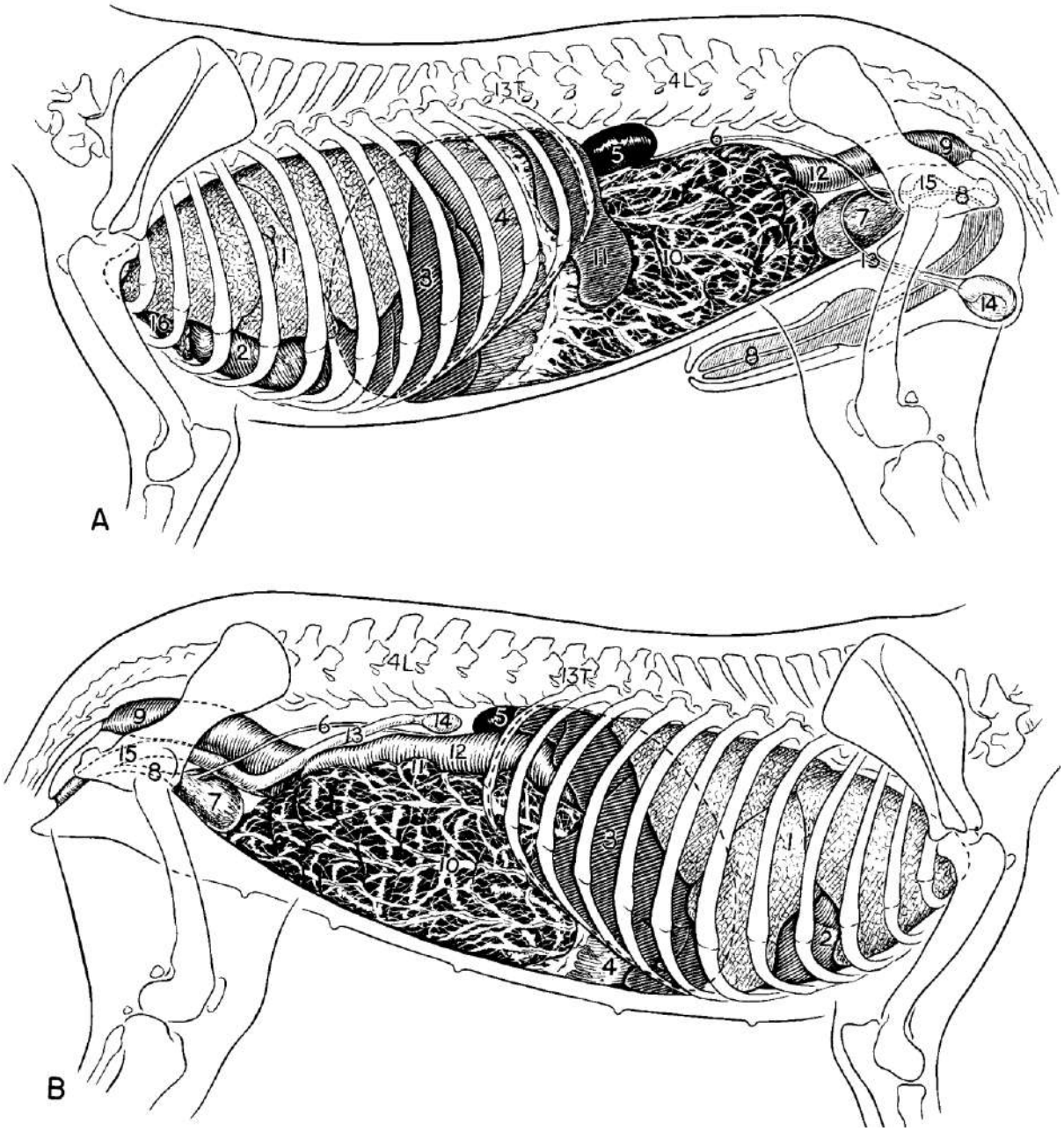
Tonsils

The **tonsil** (tonsilla) is a diffuse or compact, relatively wide aggregation of the lymph tissue, located in the wall of the oral part of the pharynx.

Name of Tonsil	*Tonsil of Cattle*	*Tonsil of Horse*	*Tonsil of Dog*
tonsilla palatina	+	+	+
tonsilla palatina impar	–	+	–
tonsilla lingualis	+	+	–
tonsilla pharyngea	+	+	+
tonsilla tubaria	–	+	–



Frontal section of head and neck through the digestive tube of dog



Viscera of dog

A. Viscera of male, left lateral aspect.
1 – left lung, 2 – heart, 3 – liver, 4 – stomach, 5 – left kidney, 6 – ureter,7 – bladder, 8 – urethra, 9 – rectum, 10 – greater omentum, covering small intestine, 11 – spleen, 12 – descending colon, 13 –ductus deferens, 14 – left testis, 15 – prostate.

B. Viscera of female, right lateral aspect.
1 – right lung, 2 – heart, 3 – liver, 4 – stomach, 5 – right kidney, 6 – ureter, 7 – bladder, 8 – urethra, 9 – rectum, 10 – greater omentum, covering small intestine, 11 – cecum, 12 – descending duodenum, 12 – ductus deferens, 13 – right uterine horn, 14 – right ovary.

FOREGUT

The foregut includes:

- **esophagus** – esophagus
- **stomach** – gaster, s. venter, s. stomachus

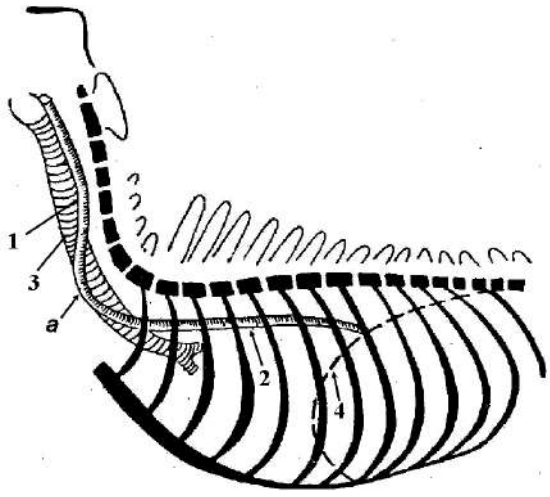
ESOPHAGUS

The **esophagus,** the first part of the socalled alimentary canal, is the connecting tube between the *pharynx* and the *stomach*. Since this passage traverses most of the neck and all thorax, and ends upon entering the abdomen, it is divided into *cervical*, *thoracic*, and *abdominal* portions. The esophagus ends at the cardia of the stomach.

The **cervical part** (pars cervicalis) of the esophagus is located in the neck visceral space, mainly dorsally to the trachea. The **thoracic part** (pars thoracica) of the esophagus extends from the thoracic inlet to the esophageal hiatus of the diaphragm. At first, it usually lies to the left of the trachea between the widely separated leaves of the dorsal part of the precardial mediastinum.

The **abdominal part** (pars abdominalis) of the esophagus is its wedge-shaped terminal part. Dorsally, the esophagus immediately joins the stomach.

The esophagus has three coats; fibrous, muscular, and mucous. In the cervical region, the fibrous coat, or **adventitia** (tunica adventitia), blends with the deep cervical fascia dorsally and on the left, and with the fascia which forms the carotid sheath on the right. The adventitia of the thoracic and abdominal portions of the esophagus blends with the endothoracic and the transversalis fascia, respectively. It is covered by pleura in the thorax and with peritoneum in the abdomen.



The **muscular coat** consists of two oblique layers of striated muscle fibers. The **mucous coat** is pale, lies in longitudinal folds which obliterate the lumen except during deglutition.

Topography of esophagus

1 – cervical part
2 – thoracic part
3 – trahcea
4 – diaphragm
a – ansa of esophagus

STOMACH

The **stomach** (venter, s. gaster, s. stomachus) is a largest dilatation of the alimentary canal. It is a musculoglandular organ that is located between the esophagus and the small intestine. The stomach lies largely in a transverse position,

more to the left of the median plane than to the right of it.

The *inlet* of the stomach is called the **cardia** (ostium cardiacum), and the *outlet* the **pylorus** (ostium piloricum).

The stomach has two surfaces:

- **diaphragmatic** – facies diaphragmalis
- **visceral** – facies visceralis

The **greater curvature of stomach** (curvatura ventriculi major) is convex, and extends from the cardia to the pylorus. The greater omentum attaches to the greater curvature.

The **lesser curvature of stomach** (curvatura ventriculi minor) also runs from the cardia to the pylorus, and is the shortest distance between these two parts.

The major divisions of the stomach are the *cardiac part*, *fundus*, *body*, and *pyloric part*.

The **cardiac part** (pars cardiaca) of stomach is that portion which blends with the esophagus. The **fundus** of stomach (fundus ventriculi) is the large blind outpocketing located to the left and dorsal to the cardia. The **body** of the stomach (corpus ventriculi) is the large middle portion of the organ. It extends from the fundus on the left to the pyloric portion on the right.

The **pyloric part** (pars pylorica) is approximately the distal third of the stomach as measured along the lesser curvature.

Coats of stomach

The wall of the stomach has **three** coats.

The **mucous coat** (tunica mucosa) consists of a glands. The glands of the stomach are known as the gastric glands (glandulae gastricae).

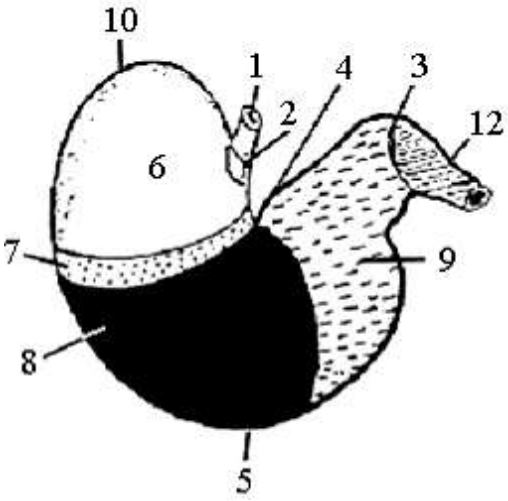
Three types of gastric glands are recognized in the animals. These are the:

- **cardiac glands** (gll. cardiacae)
- **gastric glands proper** (gll. gastricae (propriae)
- **pyloric glands** (gll. pyloricae)

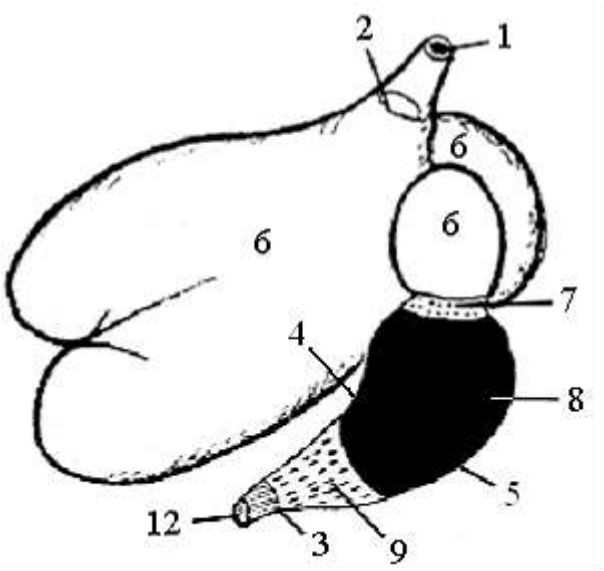
The cardiac glands are found in a narrow zone around the cardia. The gastric glands proper, or fundic glands, occupy about two-thirds of the gastric mucosa. This includes the left extremity, or fundus, and the body of the stomach. It is exclusive of the pyloric part and the cardiac gland region. The pyloric glands are found in the pyloric part of the stomach.

The **muscular coat** (tunica muscularis) of the stomach consists of an outer longitudinal and an inner circular layer of smooth muscle fibers. To these layers are added oblique fibers over the body of the stomach. The *circular layer* (stratum circulare) of the stomach is more complete and specialized than is the longitudinal layer. The pylorus, which opens into the duodenum, is surrounded by a circular muscle termed the **pyloric sphincter** (m. sphincter pylori). The *oblique layer* (stratum obliquae) are adjacent to the mucosa.

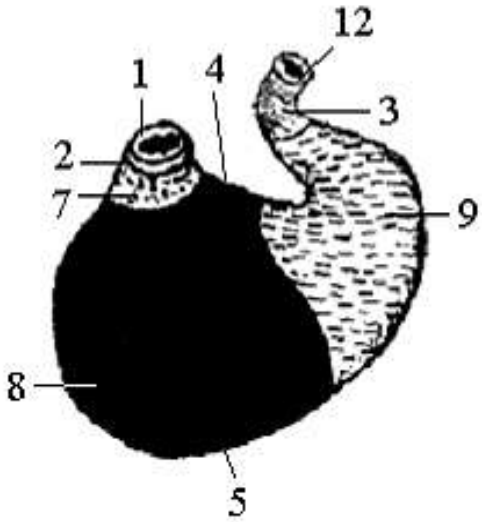
The **serous coat** (tunica serosa) covers the stomach. The serosa of the stomach is extremely thin and elastic. It adheres closely to the stomach musculature. Serosa forms the greater omentum and lesser omentum.



Scheme of stomach of horse



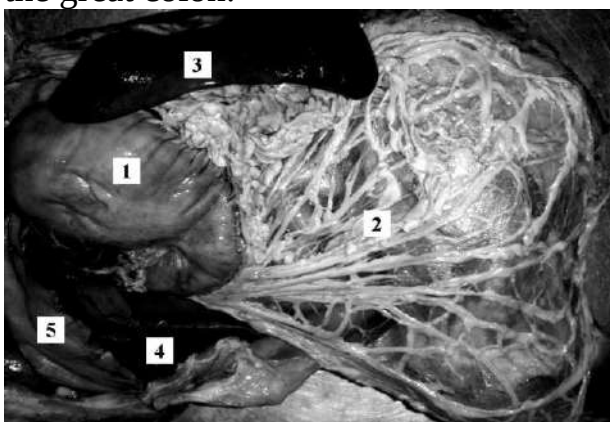
Scheme of stomach of ruminants



Scheme of stomach of dog

1 – esophagus
2 – cardia
3 – pylorus
4 – lesser curvature
5 – greater curvature
6 – nonglandular part of mucosa
7 – cardiac glands
8 – gastric glands
9 – pyloric gland
10 – blind sac
12 – duodenum

The **greater omentum** (omentum majus, s. epiploon) connects the ventral part of the great curvature and the first curve of the duodenum with the terminal part of the great colon.



Greater omentum of the dog
(photo of anatomical specimen)
1 – stomach, 2 – greater omentum, 3 – lesser omentum,4 – liver, 5 – diaphragm

The greater omentum has many functions, yet when it is largely removed, it does not regenerate. The greater omentum is used frequently by the surgeon because of the important part it plays in localizing infection and aiding in the revascularization of tissues which have had their normal blood supply impaired. The omentum moves in the direction of blood flow. The mobility of the omentum is also facilitated by peristalsis.

The **omental bursa** (bursa omentalis), or lesser peritoneal cavity, is potentially a large cavity, completely collapsed in life, which is mainly enclosed by the omenta. The omental bursa has but one large, constantly present opening into the greater or main peritoneal cavity, which is called the **epiploic foramen** (foramen epiploicum).

The **lesser omentum** (omentum minus) connects the lesser curvature and the first part of the duodenum with the liver below the oesophageal notch and the portal fissure.

Stomach of horse

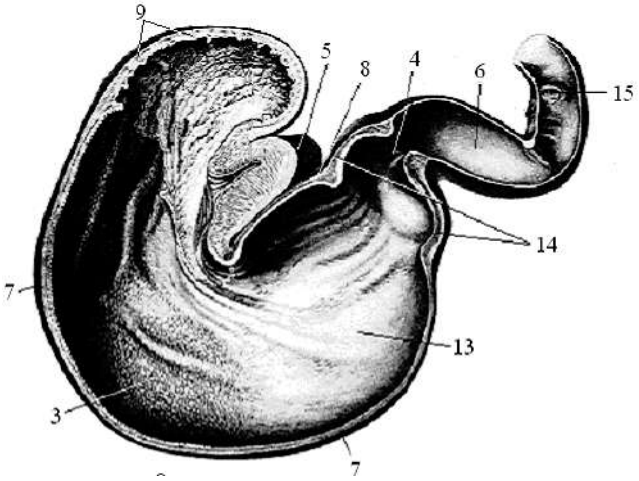
1. The mucous membrane at the cardiac part resembles the oesophageal mucous membrane, and is termed a **blind sac** (saccus cacus)**.** It is white in color, destitute of glands.

2. At the cardiac orifice presents numerous folds which occlude the opening. It is a **cardiac sphincter**.

3. The mucosa of **blind sac** is clearly delimited from the cardiac glands by a plicated edge margin (margo plicatus).

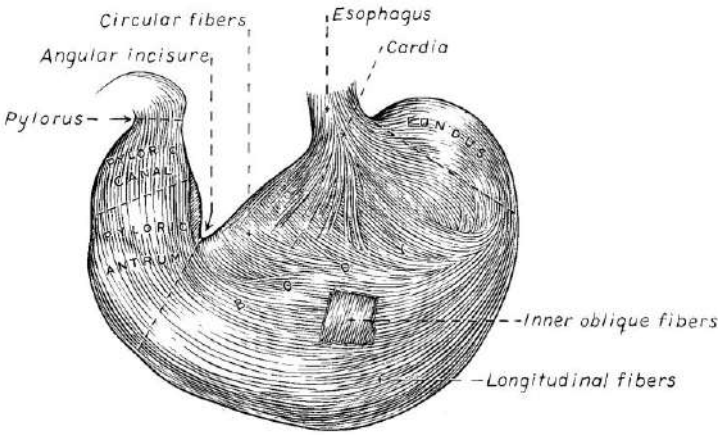
4. The small curvature forms an **angular notch** (incisura angularis).

5. A larger omentum is small in size.



Stomach of horse

1 – cardia, 2 – fundus of stomach, 3 – body of stomach, 4 – pylorus, 5 – esophagus, 6 – duodenum, 7 – greater curvature, 8 – lesser curvature, 9 – blind sac, 10 – nonglandular part, 11 – cardiac glands, 12 – gastric glands, 13 – pyloric glands, 14 – pyloric sphincter, 15 – papilla of bile duct.



Stomach of dog

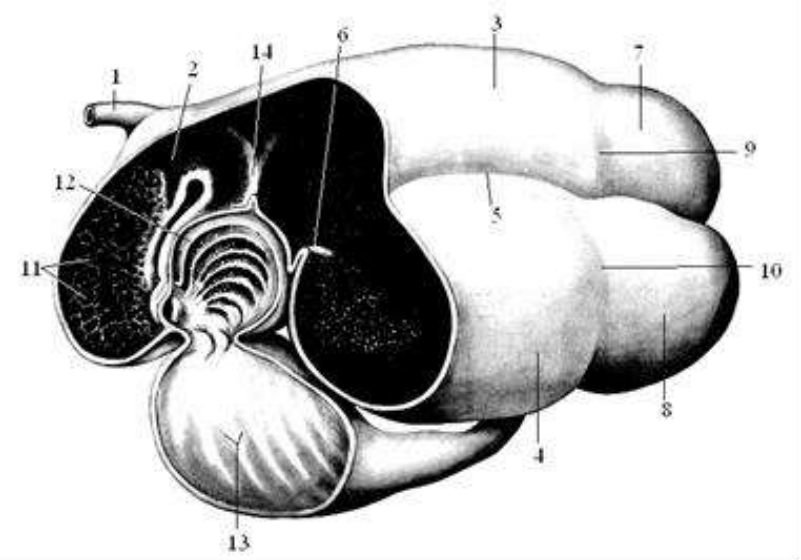
1. The stomach is relatively large.
2. Cardiac glands are found in a very narrow pale zone around the cardiac opening, and also scattered along the lesser curvature.
3. The larger omentum is huge. It separates the ventral abdominal wall from intestine.

STOMACH OF CATTLE

The **stomach of the cattle** is very large. It is compound, being composed of four divisions: **rumen, reticulum, omasum,** and **abomasum.** The first three divisions may be regarded as **forestomach**, the fourth being the stomach proper. The oesophagus opens into the stomach on a sort of dome formed by the rumen and reticulum, and is continued through the latter by the groove of reticulum.

From the ventral end of the latter a groove traverses the ventral wall of the omasum, thus giving a direct path to the abomasum for finely divided or fluid food. The abomasum joins the small intestine.

The sizes of the four parts vary with age. In the new-born calf the rumen and reticulum together are about half as large as the abomasum; in ten or twelve weeks this ratio is reversed. During this period the omasum appears to be contracted and functionless. At four months the rumen and reticulum together are about four times as large as the omasum and abomasum together. At about one and one-half years the omasum equals the abomasum in capacity.

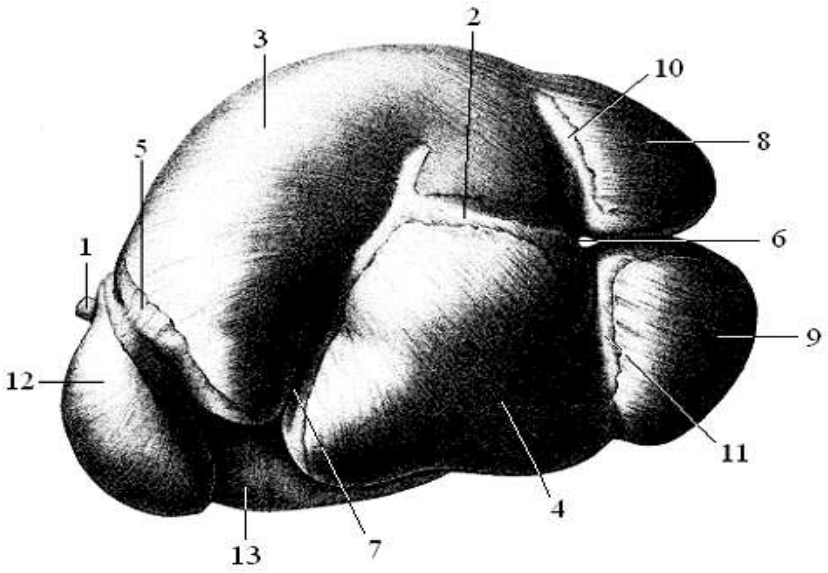


Stomach of ruminants

1 - esophagus
2 - vestibule of the rumen
3 - dorsal sac
4 - ventral sac
5 - left longitudinal groove
6 - right longitudinal pillar
7 - dorsal blind sac
8 - ventral blind sac
9 - dorsal coronary groove
10 - ventral coronary groove
11 - reticulum
12 - omasum
13 - spiral folds of mucousa of abomasum
14 - cranial pillar

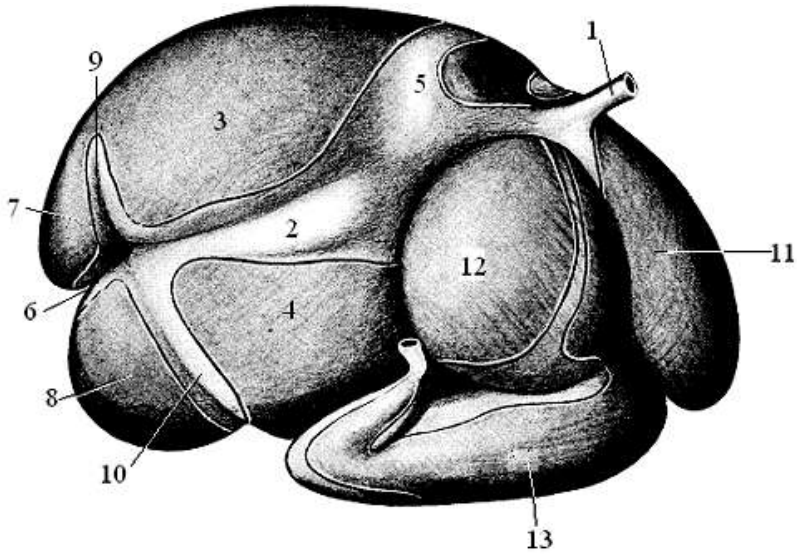
RUMEN

The **rumen** occupies almost all left half of the abdominal cavity. It is somewhat compressed laterally, and may be described as having two **surfaces**, two **curvatures** or borders, and two **extremities**. The **parietal** (or left) **surface** (facies parietalis) is convex and is related to the diaphragm, spleen, and the left wall of the abdomen. It extends almost to the pelvis. The **visceral** (or right) **surface** (facies visceralis) is related to the omasum and abomasum, the intestine, the liver, pancreas, kidneys, the uterus in the female. The **dorsal curvature** (curvatura dorsalis) is convex, following the curve formed by the diaphragm and sublumbar muscles. It is firmly attached to the sublumbar muscles by peritoneum and connective tissue. The **ventral curvature** is also convex and lies on the floor of the abdomen. The surfaces are marked by the right and left **longitudinal groove** (sulci longitudinales), which indicate externally the division of the rumen into **dorsal** and **ventral sacs**.



Stomach of cattle
(left aspect)

1 – esophagus
2 – left longitudinal groove
3 – dorsal sac
4 – ventral sac
5 – ruminoreticular groove
6 – caudal groove
7 – cranial groove
8 – dorsal blind sac
9 – ventral blind sac
10 – dorsal coronary groove
11 – ventral coronary groove
12 – reticulum
13 – omasum



Stomach of cattle
(right aspect)

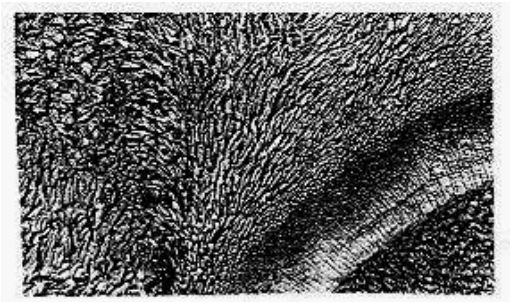
1 – esophagus
2 – right longitudinal groove
3 – dorsal sac
4 – ventral sac
5 – atrium of rumen
6 – caudal groove
7 – caudodorsal blind sac
8 – caudoventral blind sac
9 – dorsal coronary groove
10 – ventral coronary groove
12 – reticulum
13 – omasum
13 – abomasum

The **cranial** (or reticular) **end** (extremitas cranialis) is divided ventrally by a **transverse groove** (sulcus ruminis cranialis) into two sacs. Dorsally, the rumen and reticulum together forming a **atrium** (atrium ruminis) on which the oesophagus terminates.

The **caudal** (or pelvic) **end** (extremitas caudalis) extends to the pubis, and is related to the intestine and bladder, and the uterus in the cow. It is divided into **caudodorsal blind sacs** and **caudoventral blind sacs** (saccus caecus caudalis dorsalis et ventralis) by a transverse caugal groove (sulcus ruminis caudalis) in which the longitudinal furrows terminate. The blind sacs are marked off from the remainder of the rumen by the **dorsal** and **ventral coronary groove** (sulcus coronarius dorsalis et ventralis).

The cavity of the rumen is partially divided into dorsal and ventral sacs by the **pillars**; these are folds of the wall, strengthened by additional muscular fibers, and correspond with the the **grooves** on the outside.

The **mucous membrane** of the first three divisions is destitute of glands. The corium is papillated. The **mucousa** of rumen forms **papillae ruminis**, they are absent on the pillars. The **muscular coat of the rumen** consists of an external longitudinal, and a thicker internal circular layer. The latter forms the bulk of the chief pillars. The **serous coat** invests all free surface of the stomach.



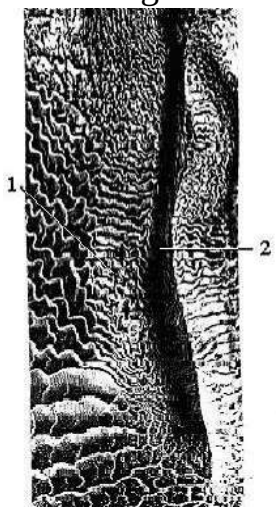
Papillae of rumen

RETICULUM

The **reticulum** is the smallest of the four divisions of the stomach. It lies on the concave surface of the diaphragm. It is somewhat pyriform, but much compressed from before backward. The **parietal** or **phrenic surface** (facies diaphragmatica) is convex and lies against the diaphragm and liver. The **ruminal surface** (facies ruminalis) is flattened by the pressure of the other three compartments; it is joined with rumen by the large **ruminoreticular orifice**. The **omasal** (or right) **surface** is connected with the omasum by **reticuloomasal orifice** (ostium reticuloomasicum). It is rounded, and is limited below and laterally by the junction of the lips of the groove of reticulum.

In the reticulum the **mucous membrane** is raised into folds, which inclose four-, five-, or six-sided spaces (cellulae reticuli); this has also the popular term "honeycomb." These cells are subdivided by smaller folds, and the bottoms are studded with pointed horny papillae. At the reticulo-omasal orifice there are peculiar horny papillae, which are curved and resemble the claws of a small bird. The **muscular coat of the reticulum** consists of two layers which begin and end at the groove of reticulum.

Cellulae of reticulum



1 – lips, 2 – floor

Reticular groove

The **reticular groove** (sulcus reticuli) consists of **floor of reticular groove** (fundus sulci reticuli) and two **lips, left and right** (*labium dextrum et sinistrum).*

It is a semicanal which begins at the cardia and passes ventrally on the right wall of the reticulum to end at the reticulo-omasal orifice. Its axial direction is practically vertical, but it is twisted in a spiral fashion; thus its thickened edges or **lips** project first backward, then to the left, and finally forward. The twist involves chiefly the left lip, and the relative position of the lips is reversed at the ventral end.

OMASUM

The **omasum** is ellipsoidal in form and somewhat compressed laterally. The right surface lies against the diaphragm, liver, and lateral wall of the abdomen. The left surface is in contact with the rumen and reticulum. The omasum has **curvature** and **base** which is the connection with the reticulum. The **muscular coat** of **the omasum** consists of a external longitudinal layer and a thick internal circular layer.

Cross section of omasum

Omasal folds:
1 - large
2 - medium
3 - small
4 - smallest

5 – omasal base
6 – omasal canal

The cavity of the omasum is occupied to a considerable extent by about a hundred longitudinal folds, the **omasal folds** (laminae omasi), which spring from the curvature. If cross-section is made, it will be seen that there is a second order of shorter laminae, and a third order still shorter; finally, there is a series of very low folds or lines. The food is pressed into thin layers in the narrow spaces between the laminae (recessus interlaminares), and reduced to a fine state of division by being ground down by the numerous rounded horny papillae which stud the surfaces of the folds. The ventral wall of the omasum forms a **omasal canal** (canalis omasi), which connects the **reticuloomasal orifice** with the **omasoabomasal orifice**. It is free from leaves, and forms a direct path from the reticulum to the abomasum for fluid and finely divided food. The **omasoabomasal orifice** (ostium omasoabomasicum) is oval. It is bounded by a two folds or sails (vela abomasica), which prevent regurgitation of the contents of the abomasum.

ABOMASUM

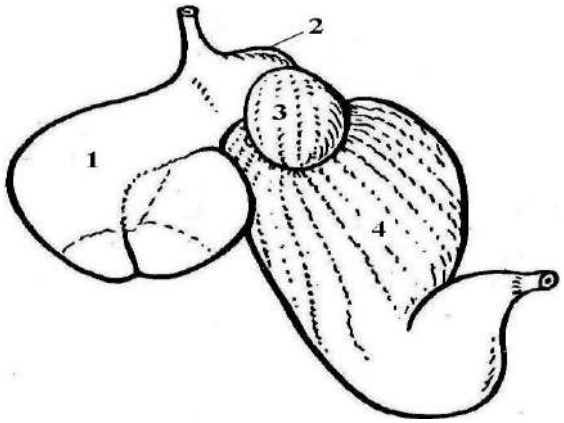
The **abomasum** lies for the most part on the abdominal floor, to the right of the ventral sac of the rumen. Its narrow posterior part is strongly curved, the concavity being dorsal. The right surface lies against the abdominal wall. The left surface is related to the ventral sac of the rumen. The **minor curvature** (curvatura minor) is concave, and is in contact with the omasum. The **major curvature** (curvatura major) is convex, and rests on the abdominal wall from the xiphoid cartilage to the ventral part of the last intercostal space. The **cavity** of the abomasum is divided by a constriction into two areas. The first of these (fundus gland region) is lined with a mucous membrane, which forms large, slightly spiral **folds** (plicae spirales). The second part (pyloric region) is much narrower. The **mucous membrane of the abomasum** is glandular. A small cardiac gland zone surrounds the omaso-abomasal orifice. The **pyloric orifice** is small and round.

The short fundus glands occur in that part which presents the large folds, while the long pyloric glands are found in the remainder, except about the omaso-abomasal orifice, where cardiac glands occur. The mucosa has a round prominence on the pyloric valve (torus piloricus). The **muscular coat of the abomasum** consists of longitudinal and circular layers; the latter forms a **pyloric sphincter**.

The outer tunic of stomach is **serosa**, it forms the omentums.

The **lesser omentum** (omentum minus) attaches the right surface of the omasum and the pyloric portion of the abomasum to the visceral surface of the liver. There is a fold between the ventral curvature of the omasum and the dorsal curvature of the abomasum.

The **great omentum** (omentum majus) is formed by the peritoneum leaving the stomach along the left longitudinal and posterior transverse furrows and the right surface of the rumen below the longitudinal furrow, also the ventral curvature of the abomasum. Its ventral part is attached on the right to the duodenum, while the dorsal part blends with the mesentery. It covers the ventral sac of the rumen almost entirely. It contains a large amount of fat in animals in good condition. The **epiploic foramen** is almost sagittal in direction.



Stomach of newborn calf

1 – rumen
2 – reticulum
3 – omasum
4 – abomasum

INTESTINE

The **intestine (intestinum, s. enteron)** consists of:

- **small intestine** (intestinum tenue)
- **large intestine** (intestinum crassum)

The content of the intestine is called **chyme.**

MIDGUT

1. Small intestine (intestinum tenue):

- **duodenum**
- **jejunum**
- **ileum**

2. Extramural digestive glands:

- **liver (**hepar)
- **pancreas**

SMALL INTESTINE

The **small intestine** (intestinum tenue) is the tube which connects the stomach with the large intestine.It extends from the pylorus of the stomach to the ileocolic orifice leading into the large intestine. It is the longest portion of the alimentary canal.

The glands of the small intestine are of three kinds:

1. The **intestinal glands** (glandule intestinales) are found throughout. They are simple tubular glands which open between the villi.

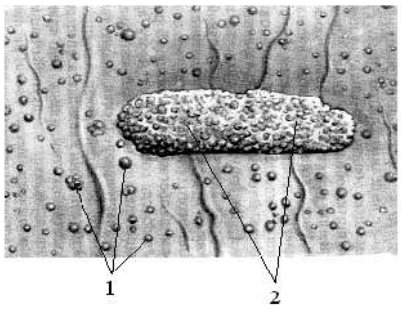
2. The **duodenal glands** (glandulae duodenales) are found in the first part of the bowel. They are racemose glands, their ducts perforate the mucous membrane.

There is also the goblet, **mucus-producing cells**.

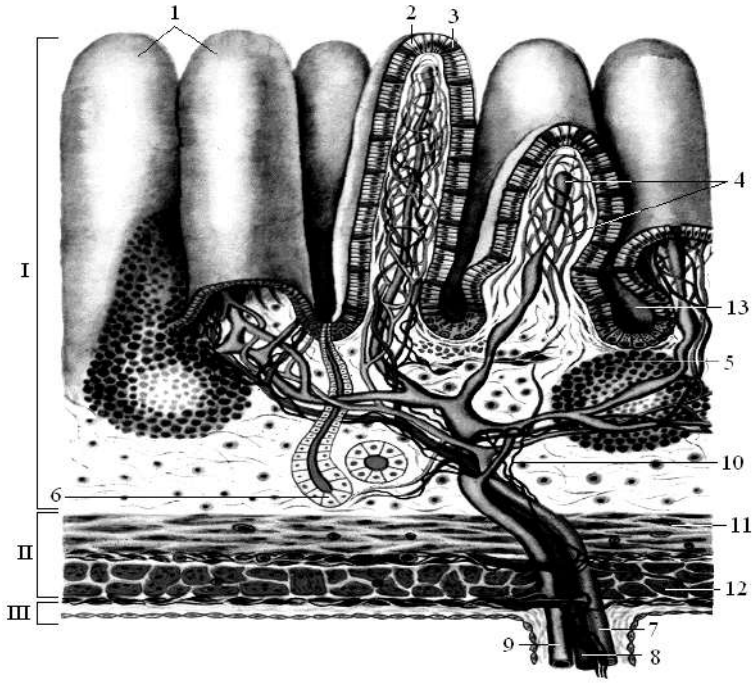
With the intestinal wall are connected extramural digestive glands: liver and pancreas. Their secrets open into the lumen of the duodenum through the excretory ducts.

The small intestine is composed of **mucous**, **muscular**, and **serous** tunics.

The **mucous coat** (tunica mucosa) is soft and velvety. The mucousa throughout the small intestine presents the innumerable intestinal villi (villi intestinales). The villi account for most of this large surface area. The deeper part of the mucosa is occupied largely by the ***intestinal glands*** and diffuse ***lymphoid tissue*** and single ***nodules***. The lymphoid follicles are grouped together to form the ***aggregated nodules*** (noduli lymphatici aggregati).



Fragment of jejunal mucosa
1 - lymphoid nodules
2 - lymphoid aggregate



Scheme of structure of the wall of the small intestine

I – mucosa, II – muscular tunic,
III – serous tunic

1 – intestinal villi, 2 – epithelium, 3 – goblet cells, 4 – vessels and nerves, 5 – lymphoid nodule, 6 – duodenal glands, 7 – vein, 8 – artery, 9 – lymphatic vessel, 10 – nerves, 11 – circular layer of muscular membrane, 12 – longitudinal layer of muscular membrane, 13 – intestinal crypt.

The **muscular coat** (tunica muscularis) consists of a relatively thin outer **longitudinal layer** (stratum longitudinale) and a thicker inner **circular layer** (stratum circulare).

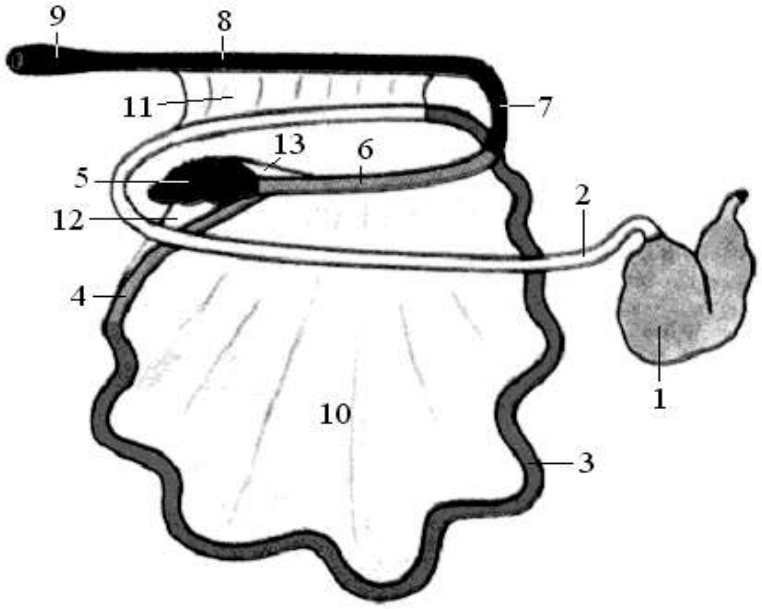
The **serous coat** (tunica serosa) of the small intestine is composed of the visceral peritoneum. The serous coat form **mesentery** (mesenterium). It is also known as the great mesentery. The serous coat is complete except at the mesenteric edge, where the vessels and nerves reach the bowel.

DUODENUM. Morphological features.

The **duodenum** is the initial and most fixed part of the small intestine, lying between the pylorus of stomach and the first loop of the jejunum. It is attached by a short peritoneal fold termed the **mesoduodenum**. It located in the right hypochondriac region. The duodenum runs mainly caudally to a transverse level through the tuber coxae, makes a U-shaped turn, and runs obliquely craniosinistrally to be continued by the jejunum.

Near to pylorus both the **pancreatic** and **bile ducts** open into the duodenum forming the **duodenal papilla**. The acid chyme which enters it from the stomach is mixed with the alkaline secretions from the liver, pancreas, and small intestinal glands. The **pancreas** is located in the mesentery of the duodenum.

The serous membrane forms ligaments when it is passed with duodenum to other organs.



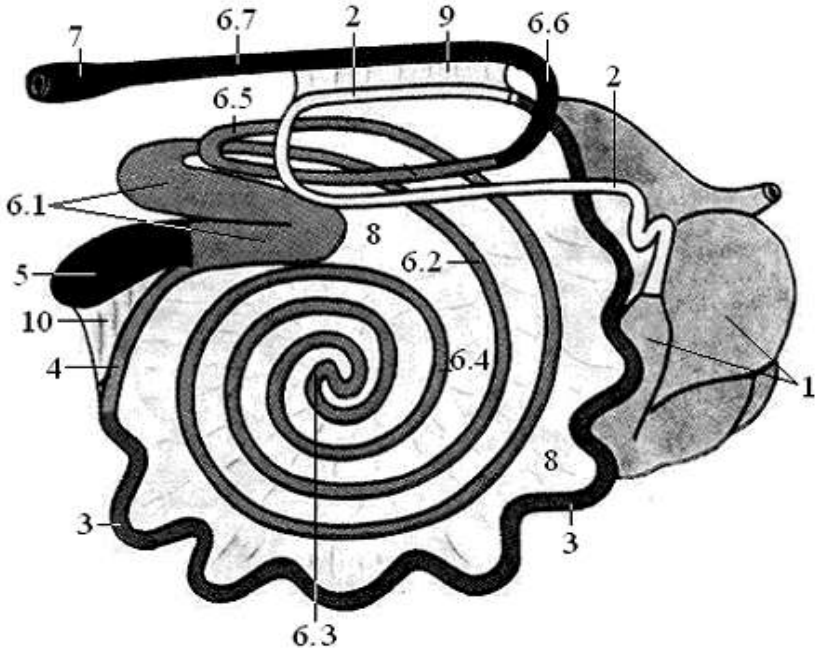
Intestine of dog

1 - stomach,
2 - duodenum,
3 - jejunum,
4 - ileum,
5 - cecum,
6 - ascending (right) colon,
7 - transverse (diaphragmatic) colon,
8 - descending (left) colon,
9 - rectum,
10 - mesentery,
11 - duodenocolic ligament,
12 – cecoiliac ligament,
13 – cecocolic ligament.

JEJUNUM. Morphological features.

The **jejunum** and **ileum** compose the bulk of the small intestine.

The **jejunum** is the middle portion of the small intestine lying between the duodenum and ileum. It has a long mesentery, and therefore easily dislocated. The jejunum forms numerous **intestinal loops** (ansa intestinales) and occupies all the free space of the abdominal cavity.

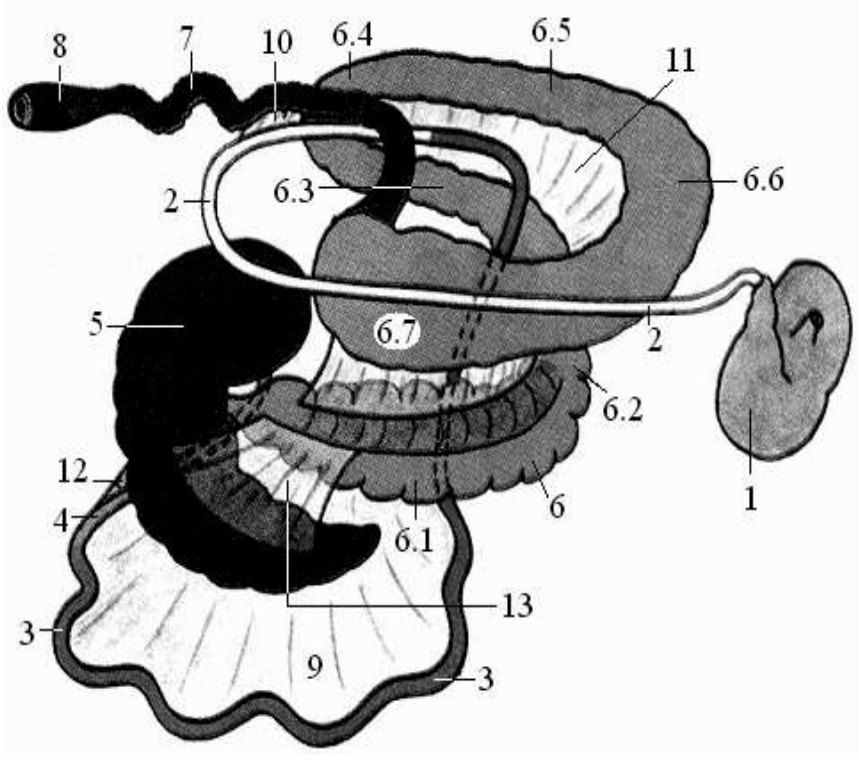


Intestine of cattle

1 - stomach,
2 - duodenum,
3 - jejunum,
4 - ileum,
5 - caecum,
6 - colon,
6.1 - proximal loop,
6.2 - centripetal coils,
6.3 - central flexure,
6.4 - centrifugal coils,
6.5 - distal loop,
6.6 - transverse colon,
6.7 – descending colon,
7 - rectum,
8 - mesentery,
9 - duodenocolic ligament,
10 - cecoiliac ligament.

ILEUM. Morphological features.

The ileum (ileum) is the terminal portion of the small intestine lying between the jejunum and large intestine. It has a short mesentery and enters the large intestine at the border of the cecum and colon, in horse – into the cecum. The cecum and ileum is connected by **cecoiliac ligament** (ligamentum ileocaecale). The ileum ends by opening into the initial portion of the ascending colon to form the **ileocolic orifice** (ostium ileocolicum). Around the opening is located the sphincter of the ileum (m. sphincter ilei). The topography of ileum – right iliac region.



Intestine of horse

1 - stomach,
2 - duodenum,
3 - jejunum,
4 - ileum,
5 - caecum,
6 - large colon
6.1 - right ventral part,
6.2 - ventral diaphragmatic flexure,
6.3 - left ventral part,
6.4 - pelvic flexure,
6.5 - left dorsal part,
6.6 - dorsal diaphragmatic flexure,
6.7 - right dorsal part,
7 - small colon,
8 - rectum,
9 - mesentery,
10 - duodenocolic ligament,
11 - intercolic ligament,
12 - cecoiliac ligament,
13 - cecocolic ligament.

LIVER

The **liver** (hepar) is the largest gland in the body. It is both exocrine and endocrine in function. The bile, which is its exocrine product, is largely stored in the gall bladder before being poured into the descending portion of the duodenum. Its endocrine substances released into the blood stream function in the intermediary metabolism of fats, sugars, and some nitrogenous products.

The **diaphragmatic surface** (facies diaphragmatica), or parietal surface, of the liver is strongly convex in all directions as it lies mainly in contact with the diaphragm. It is so strongly convex that more of this surface faces bilaterally and dorsally than faces cranially and ventrally. The postcava lies to the right of the esophagus as they groove the liver.

The **visceral surface** (facies visceralis) of the liver is irregularly concave and faces mainly caudoventrally. It lies in contact with the stomach, duodenum, pancreas, and right kidney. The liver is completely invested with peritoneum except at the hilus and where the gall bladder is fused to it.

The **porta of the liver** (porta hepatis) is the hilus of the organ. The hepatic vessels and nerves and the bile duct communicate with the gland through the porta. The nerves and arteries enter the porta dorsally, the biliary duct leaves ventrally, and the portal vein enters between the two.

Dorsal, ventral, right and left lateral borders (margo dorsalis, ventralis, lateralis dexter et lateralis sinister) are recognized. They are sharp-edged and continuous around the periphery. The **dorsal border** (margo obtusus) is thick for the most part. It presents: (1) a depression for the right kidney (impressio renalis); (2) a notch, which is the dorsal end of the fossa venae cavae; (3) a deep notch (impressio oesophagea) which is mainly occupied by the thick margin of the oesophageal opening of the diaphragm.

Rest borders are thin (margo acutus).

The liver is almost completely enveloped by **peritoneum,** which forms its **serous coat** (tunica serosa). The serous coat is fused to the underlying *fibrous capsule*. The only parietal attachment of the liver is to the diaphragm by means of continuations of its serous coats in the form of the **coronary ligament** and several small folds. These folds are the **triangular**, and the **falciform ligaments**.

The **coronary ligament of liver** (lig. coronarium hepatis) attaches it closely to the diaphragm.

The **falciform ligament of liver** (lig. falciforme hepatis) is a crescentic fold which attaches the middle lobe to the sternal part of the diaphragm and to the abdominal floor.

The **right and left triangular ligament** (ligg. triangularia dextrum et sinistrum) are a wide folds which attache the dorsal border to the costal and tendinous part of the diaphragm.

The **round ligament** (lig. teres hepatis), a fibrous cord which extends from the umbilical fissure to the umbilicus; it is the vestige of the umbilical vein, which in the foetus carries the blood from the placenta to the liver.

In addition, the liver with other organs is connected by following ligaments:

- hepato-renal (lig hepatorenale)
- hepato-gastric (lig. hepatogastricum)
- hepato-duodenal (lig. hepatoduodenale)

The last two ligaments form a *small omentum*.

The free surface of the liver is firmly covered by the thin **peritoneum** superficially and the equally thin fibrous capsule which sends septa into the gland. On close observation the surface of the liver presents a fine mottled appearance. The delicate dappling is due to the contrast in color between the dark, small, polygonal units of liver parenchyma and the connective tissue surrounding them. These units, called ***lobules*** (lobuli hepatis), are the smallest visible functional divisions of the organ. Each lobule is about 1 mm. in diameter and is composed of curved sheets of cells which enclose numerous, blood-filled cavities known as the liver sinusoids.

The **bile**, produced by the liver cells surrounded by the blood sinuses, is discharged into the minute bile canaliculi, or bile capillaries, which lie between these cells. Finally, the **common hepatic duct (**ductus hepaticae communis) originates from liver.

The **gall bladder** (vesica fellea, s. biliaris) stores and concentrates the bile. The gall bladder is a vesicle which lies between the quadrate and right lobes.

The **cystic duct** (ductus cysticus) extends from the gall bladder to the site of its junction with the hepatic duct from the liver. From this level distally to the duodenum the main excretory channel which receives bile from the hepatic ducts is known as the **bile duct** (ductus choledochus). The bile duct enters into the duodenum.

The liver is divided into lobes and sublobes by deeply running **interlobar ffissures**.

Liver of dog

Hepatic lobes are **six**. The **left lobe of liver** (lobus hepatis sinister) is that portion of the liver which lies entirely, or almost entirely, to the left of the median plane. This lobe forms from a third to nearly a half of the total liver mass. Its parenchyma is usually completely divided into two sublobes, as follows:

- *left lateral lobe of liver* (lobus hepatis sinister lateralis)
- *left medial lobe of liver* (lobus hepatis sinister medialis)

The **quadrate lobe of liver** (lobus quadratus) is a deep wedge of liver tissue which lies essentially in the median plane, where it is interposed in the fissure which separates the right medial and the left lobes.

The **right lobe of liver** (lobus hepatis dexter) lies to the right of the median plane. Like the left hepatic lobe it is divided into medial and lateral sublobes.

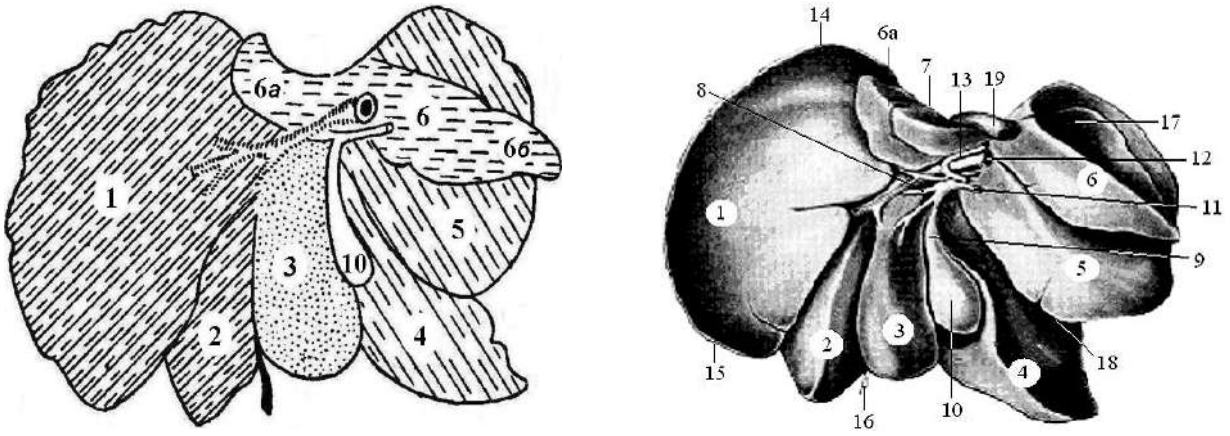
- *right medial lobe of liver* (lobus hepatis dexter medialis) is fused to the medially lying quadrate lobe
- *right lateral lobe of liver* (lobus hepatis dexter lateralis)

A *round ligament* of liver (lig. teres hepatis) that is an empty umbilical vein of the fetus passes at level of incisura between the left and quadrate lobes.

The gall bladder is located between the quadrate and right lobes below the porta of hepatis.

The **caudate lobe** (lobus caudatus) is composed of the caudate and papillary processes. The *papillary process* (processus papillaris) is centrally located. It is the most prominent feature of the visceral surface, and is usually partly subdivided by one or two fissures. The *caudate process* (processus caudatus) forms the most caudal portion of the liver.

The *renal impression* (impressio renalis) is a deep, nearly hemispherical fossa formed by the cranial pole of the right kidney projecting into the caudodorsal portion of the liver.

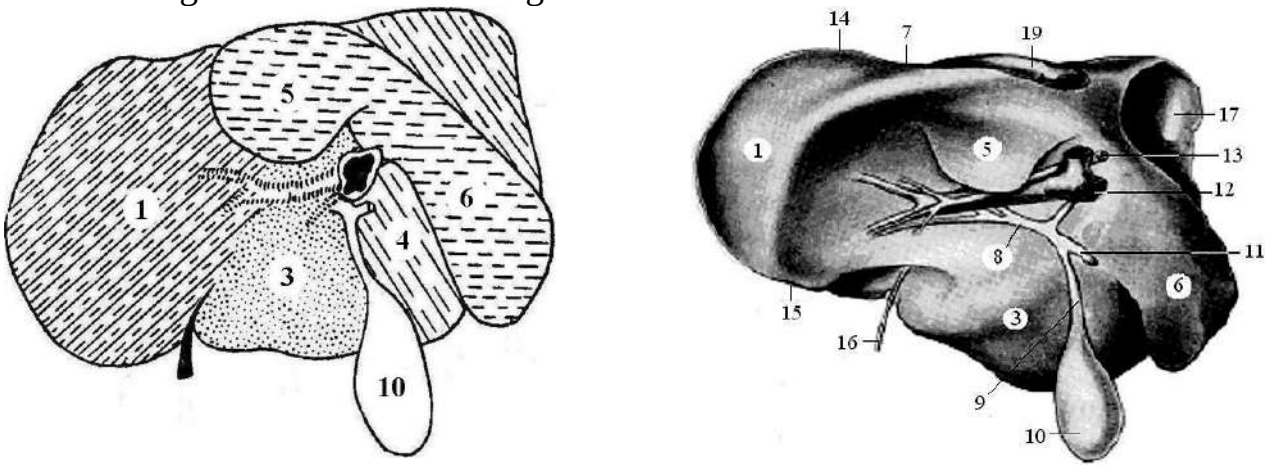


Liver of dog

Lobes: 1 – left lateral, 2 – left medial, 3 – quadrate, 4 – right medial, 5 – right lateral, 6 – caudate, 6a – papillary process of caudate lobe, 6b – caudate process of caudate lobe.
7 – esophageal impression, 8 – hepatic duct, 10 – gall bladder, 11 – bile duct, 12 – portal v., 13 – hepatic a., 14 – dorsal border, 15 – ventral border, 16 – round ligament, 17 – kidney impression, 18 – incissura, 19 – caudal vena cava.

Liver of cattle

In cattle the lobes of liver are **four.** The incisures are not deep. The gall bladder hangs below the ventral edge of the liver.

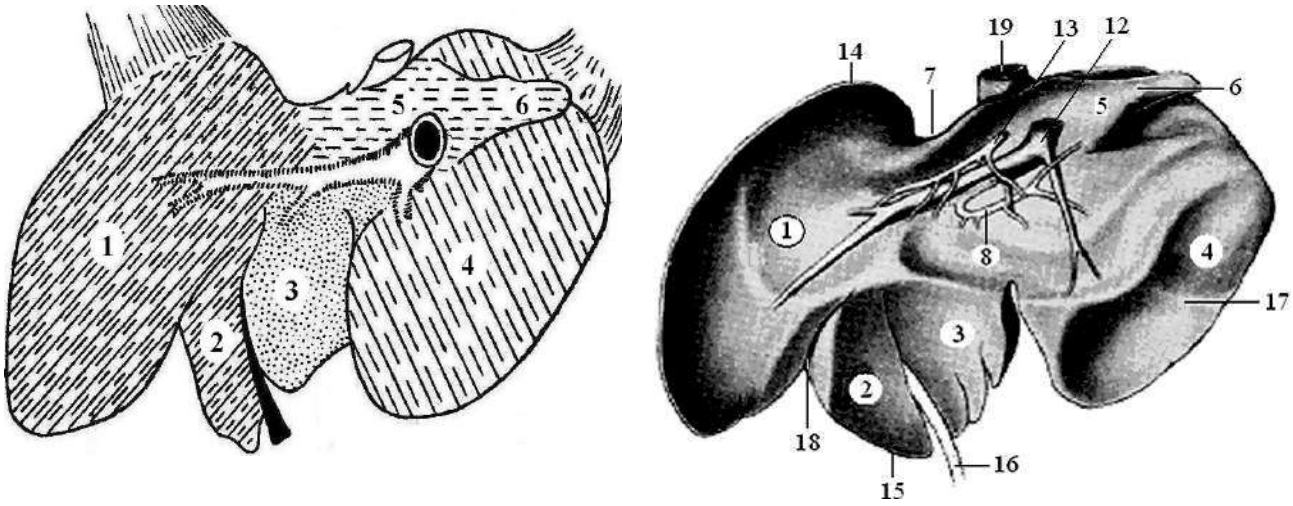


Liver of cattle

Lobes: *1 - left, 3 – quadrate, 4 – right, 5 – caudate, 6 - caudate process of caudate lobe.*
7 – esophageal impression, 8 – hepatic duct, 10 – gall bladder, 11 – bile duct, 12 – portal v., 13 – hepatic a., 14 – dorsal border, 15 – ventral border, 16 – round ligament, 17 – kidney impression, 19 – caudal vena cava.

Liver of horse

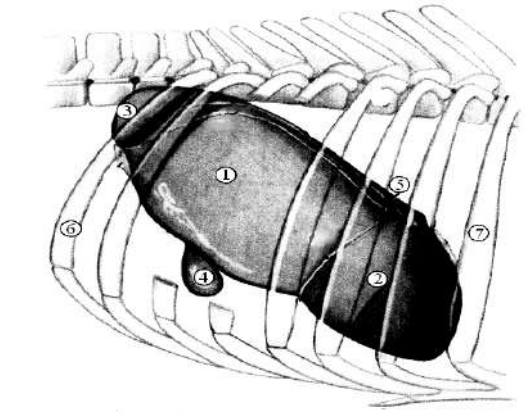
In horse the lobes of liver are **five.** The left lobe is divided into the lateral and medial. There is no gall bladder. Bile enters the duodenum through **hepatic duct.**



Liver of horse

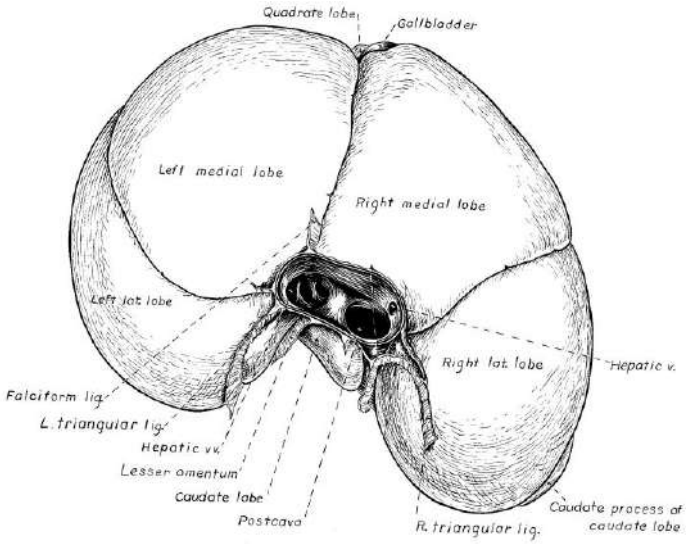
Lobes: 1 - left lateral, 2 - left medial, 3 – quadrate, 4 – right, 5 – caudate, 6 - caudate process of caudate lobe.

7 – esophageal impression, 8 – hepatic duct, 12 – portal v., 13 – hepatic a., 14 – dorsal border, 15 – ventral border, 16 – round ligament, 17 – kidney impression, 18 – incissura, 19 – caudal vena cava.



Topography of the liver of cattle
(right aspect)

1 - right lobe, 2 - left lobe, 3 - caudate lobe, 4 - gall bladder, 5 - caudal vena cava, 6 - XIII rib, 7 - VI rib.

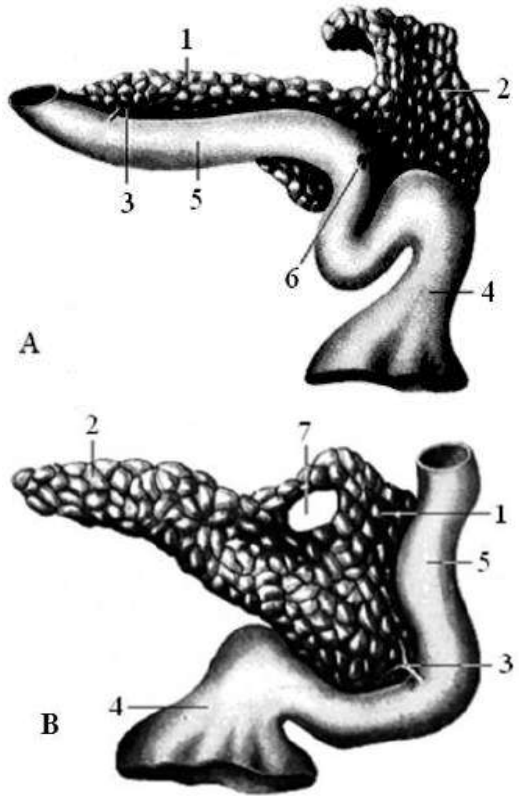


Liver of dog. Lobes and ligaments.
(diaphragmatic aspect)

PANCREAS

The **pancreas** is yellowish gray when preserved and pinkish gray in life. It is a rather coarsely lobulated, elongate gland. The pancreas is located in the dorsal part of both the epigastric and the mesogastric abdominal segment, caudal to the liver. Like the liver, the pancreas has both an exocrine and an endocrine function. Its exocrine secretion, the **pancreatic juice**, the most important of the digestive secretions, is

conveyed to the descending portion of the duodenum by one or several ducts.



Pancreas
A – cattle, B – horse

1 – right lobe, 2 – left lobe, 3 – pancreatic duct, 4 – pylorus of stomach, 5 – duodenum, 6 – orifice of bile duct, 7 – incissura for portal vein.

It is a clear alkaline secretion containing three principal enzymes, one of which reduces proteins, one fats, and the third carbohydrates.

Insulin, a protein hormone, is the endocrine secretion produced by the **islet cells**. This hormone keeps the sugar content of the blood at a constant level, and in its absence a fatal sugar diabetes sets in.

The pancreas has:

- **body** (corpus pancreatic)
- **left** lobe (lobus pancreatis sinister)
- **right** lobe (lobus pancreatis dexter)

The pancreas nearly always has **two excretory ducts.** The large one is termed the **pancreatic duct** (ductus pancreaticus). It is formed by the union of two radicles which come from the right and left lobes, and passes through the duodenal angle to end at the duodenum alongside of the bile-duct. It is wide, and is very thin-walled. The **accessory pancreatic duct** (ductus pancreaticus accessorius) arises either from the chief duct or its left radicle, and ends on a papilla in the duodenum opposite the chief duct.

HINDGUT

LARGE INTESTINE

The **large intestine** (intestinum crassum) extends from the termination of the ileum to the anus. Its most important function is the dehydration of its fecal contents. It differs from the small intestine in its greater size, in being sacculated, for the most part, possessing longitudinal bands, and having a more fixed position. It is divided into **cecum**, **colon**, and **rectum**.

The large intestine has the usual three coats as found in the small intestine. These are the **mucous**, **muscular**, and **serous** tunics or coats.

The **mucous coat** (tunica mucosa) of the large intestine differs from that of the small intestine in that there are no aggregated lymph nodules or intestinal villi. Solitary lymph nodules, however, are numerous. The **intestinal glands** (glandulae intestinales) of the large intestine are longer, straighter, and richer in **goblet cells** than are those of the small intestine.

The **muscular coat** (tunica muscularis) is uniform in thickness.

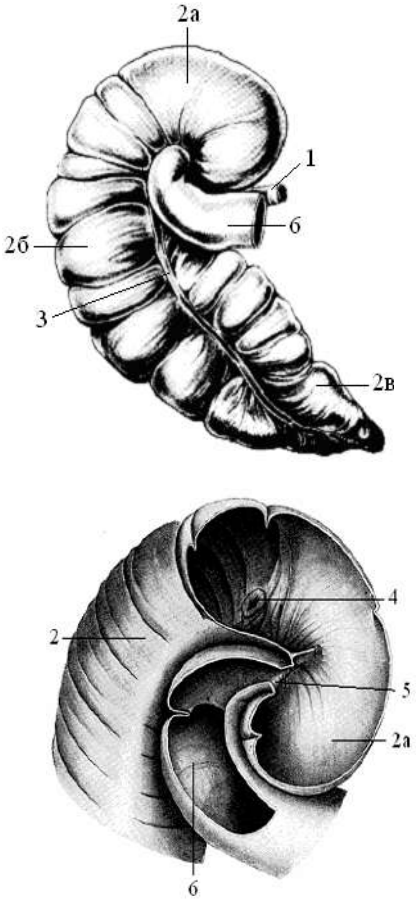
The **muscular coat** consists of **longitudinal** and **circular fibers**. The stratum longitudinale form the **bands** (teniae) between them are located the **sacculations** or **pockets** (haustra). A circular layer forms sphincters.

The **serous coat** (tunica serosa) resembles that of the small intestine. It covers the colon, cecum, and half of the rectum, as the visceral peritoneum. The anal canal and the caudal portion of the rectum are retroperitoneal (cavered by adventitia).

CECUM

The **cecum** is the first part of the large intestine. The **cecum** is a great cul-de-sac interposed between the small intestine and the colon.

Cecum of horse.



Caecum of horse

1 - ileum, 2 - caecum: 2a - base, 2b - body, 2c - apex; 3 – bands, 4 - cecoiliac orifice, 5 - cecocolical orifice, 6 - ascending colon.

The cecum is similar to a huge comma.

It has the **base, body** and **apex**. The **base of cecum** (basis caeci) has greater curvature (dorsal), and lesser (ventral). The **body of cecum** (corpus caeci) extends downward and forward from the base and rests largely on the ventral wall of the abdomen. The **apex of cecum** (apex caeci) lies usually on the abdominal floor behind the xiphoid cartilage.

The cecum has four longitudinal bands (taeniae), situated on the dorsal, ventral, right, and left surfaces; these cause four rows of sacculations (haustra).

The **ileocecal orifice** (ostium ileocaecale) is situated in the lesser curvature of the base. The end of the ileum is partially telescoped into the caecum, so that the orifice is surrounded by a fold of mucous membrane, forming the **ileocecal valve** (valvula ileocecalis).

The **cecocolic orifice** (ostium caecocolicum) is placed above and external to the preceding one. The cecocolic sphincter (m. sphincter cecocolicum) is a specialization of the inner circular muscular coat which guards the cecocolic orifice. The serous membrane of the cecum forms ligaments: **lig. cecocolicum and lig. ileocecale.**

In **cattle** cecum is cylindrical, large in diameter, has a body and apex. The wall has no bands, and is not sacculated. The blind end is directed caudally, extends to the pelvic inlet.

In **dog** the wall of the cecum forms one band. It is suspended on a short mesentery.

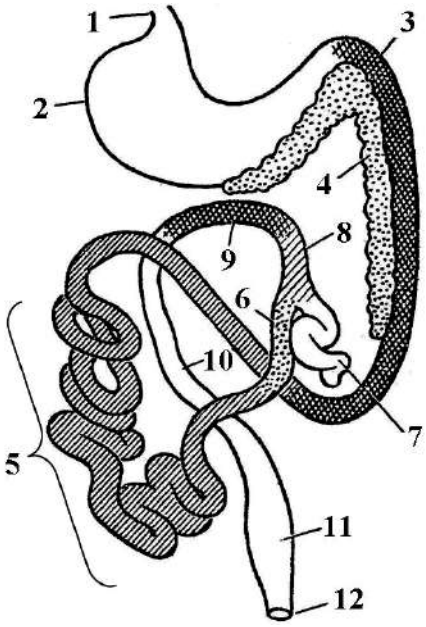
COLON

The **colon** lies between the cecum and rectum. It is divided into **ascending**, **transverse**, and **descending** portions and their connecting flexures.

The **descending colon** (colon descendens) is the longest segment of the colon. It extends to the pelvic inlet, where it is continued by the rectum without demarcation.

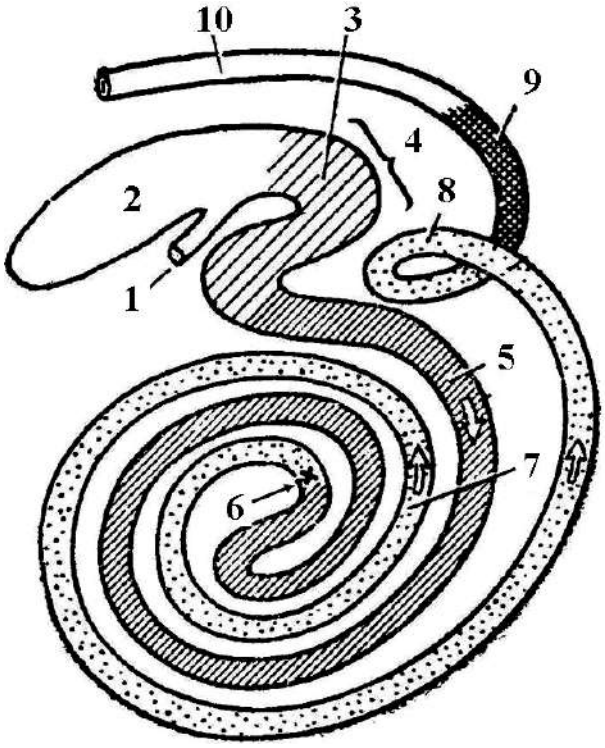
Colon of the dog

The **colon** of the **dog** forms an **arc.**
Neither haustra nor tenia exists.
In general, it is a simple tube, only slightly larger in diameter than the small intestine.



Gastrointestinal tract of dog

1 – esophagus, 2 – stomach, 3 – duodenum, 4 – pancreas, 5 – jejunum, 6 – ileum, 7 – cecum, 8 – ascending colon, 9 – transverse colon, 10 – descending colon, 11 – rectum, 12 – anus.



Colon of cattle

In ruminant animals the ascending colon forms a **disk**.

1 - ileum
2 - caecum
3 - colon:
4 - proximal loop (ansa proximalis coli)
5 - centripetal coils
(gyri coli centripetales)
6 - central flexura (flexura centralis)
7 - centrifugal coils
(gyri coli centrifugales)
8 - distal loop (ansa distalis coli)
9 - transverse colon (colon transversum)
10 - descending colon (colon descendens)

The first part (ansa proximalis) is marked off from the cecum only by the ileocecal opening; it forms an S-shaped curve and is continued by the spiral part (ansa spiralis). The bowel gradually diminishes in caliber, and the terminal part (ansa distalis) leaves the spiral mass, and turns backward between the duodenum and the

initial sigmoid part. From the ventral surface of the right kidney it passes backward, forms an S-shaped curve near the pelvic inlet, and joins the rectum; this part is attached to the sublumbar muscles by a short mesentery.

Colon of horse

The ascending colon is called the **great colon** (colon crassum), and the transverse colon (colon transversum) and descending colon (colon descendens) are united into the **small colon** (colon tenue).

The great colon forms two half-loops: the ventral and dorsal that are connected by **mesocolon**.

Position of the **great colon:**

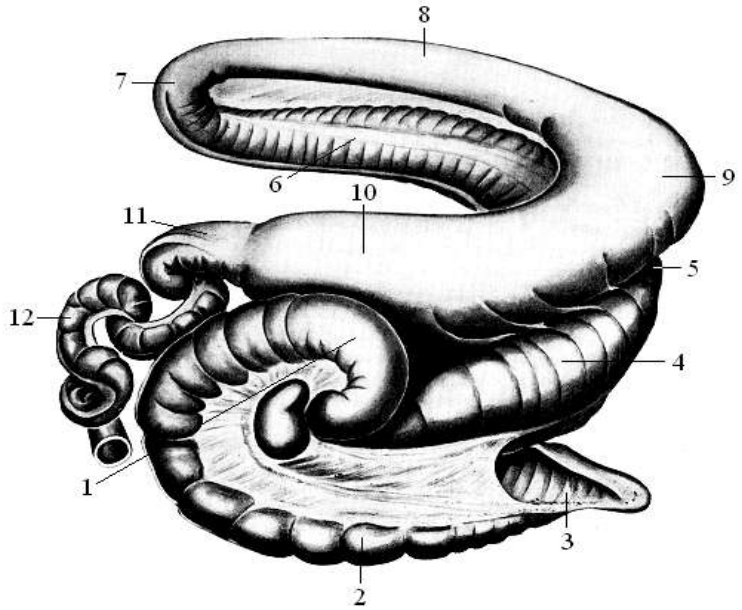
- **right ventral colon** (colon ventrale dextrum)
- **diaphragmatic ventral flexura** (flexura coli diaphragmatica ventralis)
- **left ventral colon** (colon ventrale sinistrum)
- **pelvic flexura** (flexura coli pelvina)
- **left dorsal colon** (colon dorsale sinistrum)
- **diaphragmatic dorsal flexura** (flexura coli diaphragmatica dorsalis)
- **right dorsal colon** (colon dorsale dextrum)

The ventral portions of the colon have **four** longitudinal muscular **bands** which produce **four rows** of sacculations (haustra). The pelvic flexure and left dorsal position are **non-sacculated**.

Near the diaphragmatic flexure bands appear, so that the flexure has **three bands** and **three rows of sacculations**.

The right dorsal part is **non-sacculated.** It forms a **gastric dilatation** (ampulla coli).

The **small colon** (colon tenue) begins at the termination of the great colon, and is continued by the rectum at the pelvic inlet. There are **two taeniae** and **two rows of sacculations**.



Cecum and colon of horse

Cecum: *1 - base, 2 - body, 3 - apex*

Large colon:
4 - right ventral colon
5 - diaphragmatic ventral flexura
6 - left ventral colon
7 - pelvic flexura
8 - left dorsal colon
9 - diaphragmatic dorsal flexura
10 - right dorsal colon

Small colon:
11 - transverse colon
12 - descending colon

RECTUM

The **rectum** is the terminal part of the bowel; it extends from the pelvic inlet to the anus. The **rectum** is continuous cranially with the descending colon; it ends caudally, at the beginning of the anal canal. Dorsally, the rectum is attached to the ventral surface of the sacrum by the *mesorectum.*

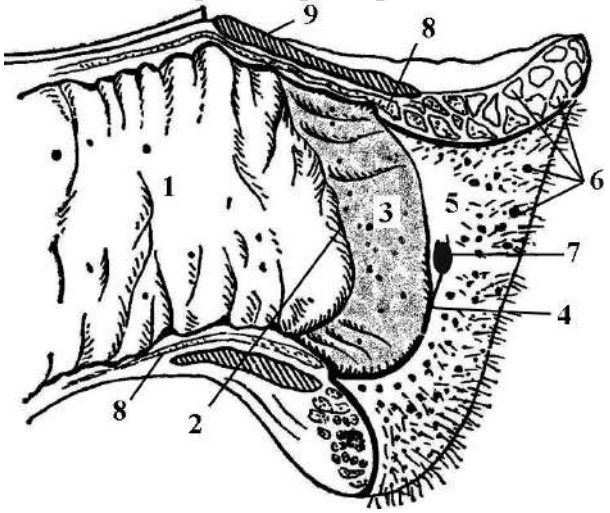
The rectum is bounded dorsally by the right and left ventral sacrococcygeal muscles. Laterally it is bounded primarily by the levator ani (medial coccygeal) muscle. Ventrally, the rectum is bounded by the vagina in the female, and by the urethra in the male.

Anal canal

The **anal canal** (canalis analis) is the terminal, specialized portion of the alimentary canal. It is extends from the termination of the rectum to the anus. The **anus** is the terminal orifice of the alimentary canal. It is situated below the root of the tail, where it forms a round projection, with a central depression when contracted. It is covered externally by an integument which is thin, hairless, and provided with numerous sebaceous and sweat glands.

There are three muscles of the anus.

- **internal anal sphincter**
- **external anal sphincter** (its action is to close the anus)
- **levator muscle of anus** (m. levator ani) – its action is to reduce the partial prolapse which the anus undergoes during defecation.



Longitudinal section of anal canal of a dog

1 – mucosa of rectum, 2 – anorectal line, 3 – intermedial zone, 4 – anocutaneous line, 5 – cutaneous zone, 6 – anal glands, 7 – anal sinus

Sphincters of anus:
8 – internal, 9 – external

The **mucosa** of the anal canal is divided into cutaneous, intermediate, and columnar zones.

The *cutaneous zone* (zona cutanea), the most caudal of the three zones of the anal canal. The duct from the anal sac opens on this zone, about 2 mm. from its cranial limit and in the depths of the lateral angle of the anus. The outer cutaneous zone may be defined as the relatively hairless zone peripheral to the anus. It has circumanal glands in the dog.

The *intermedial zone* (zona intermedia) is known as the *anocutaneous line* (linea anocutanea). Its mucosa, like the surface of the cutaneous zone. The *columnar zone* (zona columnaris), or *anal columns* run forward from the anocutaneous line. In this way, a large number of pockets are formed, called *anal sinuses* (sinus anales).

The columns are not uniform in either length or direction. Some disappear after running only a few millimeters cranially; most end in a line which encircles the anal

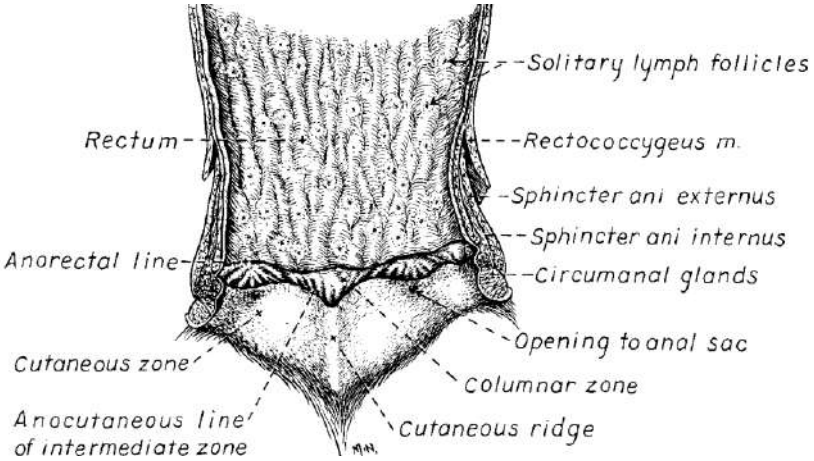
canal, known as the *anorectal line* (linea anorectalis).

The **anal sacs** (sacci anales) one on each side of the anal canal, are approximately spherical sacs which are located between the inner smooth and the outer striated sphincter muscle of the anus. The excretory duct of each sac opens between the dorsal and lateral parts of the inner cutaneous zone of the anus adjacent to the intermediate zone.

Glands of anus. Three gland areas are located in relation to the anus. These comprise the circumanal glands, the anal glands, and the glands of the anal sacs.

The **circumanal glands** (glandulae circumanales) are located around the anus in a subcutaneous zone. Circumanal gland elements are also found in the walls of the anal sac ducts. These is potentially a sebaceous gland.

The **anal glands** (glandulae anales) open to the outside in the intermediate zone. Their secretion is fatty in the dog. The **glands of paranal sinus** (glandulae sacci anales) lie in the wall of the sac and open into it. The anal sac therefore is a reservoir for the secretion of the glands of its wall.



The rectum and anal canal

RESPIRATORY APPARATUS

The **respiratory apparatus** consists of the lungs and of the air passageways which lead to the sites of gaseous exchange within the lungs. Various structures associated with these passageways modify or regulate the flow of air, serve as olfactory receptors, facilitate water and heat exchange, and make phonation possible. The nasal cavity and turbinates warm and moisten the air, and remove foreign material from it. The pharynx serves as a passageway for both the respiratory and the digestive system. The larynx guards the entrance to the trachea, functions in vocalization, and regulates both the inspiration and expiration of air. The trachea divides into the principal bronchi, and the air passageways continue in the two lungs as lobar bronchi, segmental bronchi, bronchioles, alveolar ducts, alveolar sacs, and alveoli. The terminal divisions are located in the elastic, well vascularized lungs, which passively expand and collapse in response to changes in intrathoracic pressure, created by action of the muscles of the diaphragm and thoracic wall.

Respiratory apparatus provides gas exchange between body and environment, that is, it realizes external respiration, during itoxygen moves from the outside air to blood, and carbon dioxide in the opposite direction.

In addition, the respiratory apparatus takes part in the formation of sounds, water-salt exchange, thermoregulation. In some organs of the respiratory apparatus, receptors of the olfactory analyzer are disposed, because of the manimals feel odors.

Morphofunctional characteristic of the respiratory apparatus

The respiratory apparatus has the form of a "blind" tube, wherein one (pair) opening is simultaneously inlet and outlet opening – **nostrils** *(nares).*

The respiratory apparatus is located in the cavity of the visceral tube:

- facial part of the head
- cervical visceral space
- thoracic cavity

The respiratory apparatus has a close anatomical connection with the apparatus of digestion. The pharynx is not only a common organ, but also the intersection of the respiratory and digestive tubes.

The respiratory apparatus consists of airways of the tube-like structure and parenchymal organs.

The walls of the respiratory tract have cartilages and bones, which provide a constant lumen of their cavities.

Respiratory organs are functionally connected with the circulatory system, which supplies oxygen to the cells, ensuring internal (tissue) breathing.

ANATOMICAL COMPOSITION OF THE RESPIRATORY APPARATUS

1. ***Nose*** – nasus, with the ***nasal cavity*** – cavum nasi and ***paranasal sinuses*** – sinus paranasales
2. ***Nasopharynx***
3. ***Larynx***
4. ***Trachea***
5. ***Main bronchi*** – bronchus principales
6. ***Lung*** – pneumo, s. pulmo

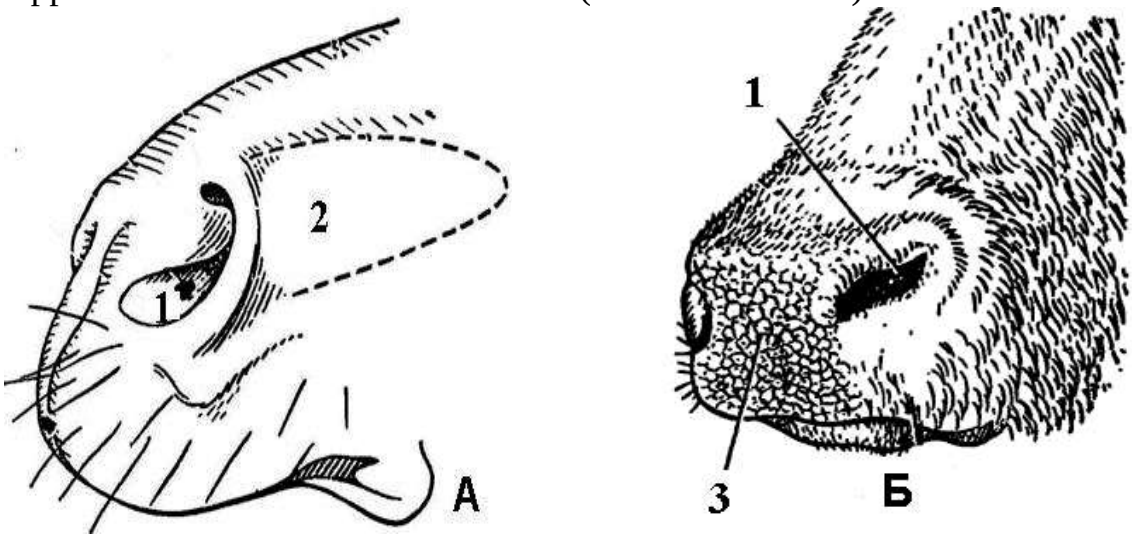
NOSE, NASAL CAVITY, PARANASAL SINUSES

The **nose** (nasus, s. rhinos) is the initial part of the respiratory tract.The nose, in a broad sense, refers to the ***external nose*** (nasus externus) and its associated ***nasal cartilages*** (cartilagines nasi), as well as to the internal nose, or ***nasal cavity*** (cavum nasi). The nose has:

- root – radix nasi
- back – dorsum nasi
- side walls – pars laterales
- tip – apex nasi

The tip of the nose is located above the upper lip. There are paired holes in it – **nostrils** (*nares),* which are limited by nose lateral and medial alaes (*alae nasilaterales et mediales).* Nostrils lead to the nasal cavity.

The **nostrils** or **anterior nares** are placed obliquely, so that they are closer together below than above. They are bounded by two ala or wings (alae nasi), which meet above and below, forming the commissures. The nostril of the horse at the upper wall has so-called **false nostril** (diverticulum nasi).



The tip of the nose

А – horse, В – cattle

1 – nostrils; 2 – projection of the nasal diverticulum, 3 – nasal plane (mirror)

The apical portion of the nose is called the ***nasal plane*** (planum nasale). The integument of the nasal plane presents epithelial elevations or papillary ridges which result in patterns characteristic for each individual. The skin around the nostrils presents long tactile hairs as well as the ordinary ones. It is continued around the alae and lines the vestibule.

The mobile part of the external nose has a framework composed entirely of the nasal cartilages. These include the impaired septal cartilage, the paired dorsal parietal and ventral parietal cartilages, and the paired accessory cartilages. Related to the ventral part of the septal cartilage is the vomeronasal cartilage.

The wing of the nostril (ala nasi) is the thickened dorsolateral portion of the nostril. The wing of the nostril contains much of the dorsal parietal and accessory cartilages.

The **nasal cavity** (cavum nasi) is the facial portion of the respiratory passageway (the cavity of the external nose). It extends from the nostrils to the choanae, being divided into right and left halves by the nasal septum.

The *septal cartilage of the nose* is a perpendicular median plate which separates of the nasal cavity into right and left nasal fossae. It is an anterior continuation of the perpendicular plate of the ethmoid bone which fails to ossify.

Each half of the nasal cavity is known as a *nasal fossa*.

Each *nasal fossa* (fossa nasalis) begins at the nostril with the nasal vestibule and ends with the choana.

The air passages thus created between the turbinates are called the nasal meatuses.

The ***nasal vestibule*** (vestibulum nasi) is largely obliterated by the large bulbous end of the alar fold which extends into it.

The ***nasolacrimal duct*** (ductus nasolacrimalis), opens into the vestibule. It carries the serous secretion from the conjunctival sac to the nasal vestibule. The internal nose functions to moisten and warm the inspired air.

The *choanae* are the openings into the nasal portion of the pharynx. They are oval in shape and oblique in position.

The various types of epithelia line the nasal: the olfactory epithelium and stratified squamous epithelium that continuous with naris and lines the nasal vestibule.

The **nasal cavity** (cavum nasi), the first segment of the respiratory tract, is a long passage, inclosed by all the facial bones except the mandible and hyoid. It is separated from the mouth ventrally by the hard palate. It opens externally at the nostrils, and communicates posteriorly with the pharynx through the posterior nares.

The *outer* tunic of the nasal cavity is skin. The *middle* tunic is represented by bones, cartilages, mimic muscles and fasciae of the head.

Internal tunic is represented by mucous membrane. In the nasal cavity (cavum nasi proprium**)**, the mucous membrane is lined with ciliated epithelium.

Under the mucous membrane of the nasal cavity is a dense **venous plexus** (plexus venosus nasi),promoting warming of inhaled air.

The nasal cavity is divided into two symmetrical halves by the median **septum nasi**. The osseous part of the **septum** (septum osseum) is formed behind by the perpendicular plate of the ethmoid and below by the vomer. The major part of it, however, is formed by the **septal cartilage** (cartilago septi nasi).

In each half, the dorsal and ventral nasal concha (*conchae nasalesdorsalis et ventralis)*are located. These covered with mucous membrane.

The mucous membrane of the dorsal nasal concha in the direction of the vestibule of nose forms **straight nose fold***(plica nasi recta),* and in front of the ventral nasal shell lie the **wing fold** (*plica alaris)*and the **fold of the nose bottom** (*plica nasi ventralis).*

The two nasal concha or turbinal bones(concha nasales) project from the lateral wall, and divide the outer part of the cavity into three **meatuses:** superior, middle, and inferior.

The **dorsal meatus** (meatus nasi dorsalis) is a narrow passage, bounded dorsally by the roof of the cavity, and ventrally by the superior turbinal bone; its posterior 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 upper part of the olfactory region.

The **middle meatus** (meatus nasi medius) lies between the two turbinal bones.

The ventral **meatus** (meatus nasi ventralis) is situated between the inferior turbinal and the floor of the cavity. It is much larger than the other two, and is the

direct passage between the nostrils and the pharynx. It carries air into the nasopharynx through the posterior naris (respiratory passage).

The **common meatus** (meatus nasi communis) is situated between the septum and the turbinals, and is continuous externally with the other meatuses.

The posterior nares (choanae) are two elliptical orifices by which the nasal cavity and pharynx communicate.

The nasal mucous membrane (membrana mucosa nasi) is thick, highly vascular, and is, in general, firmly attached to the underlying periosteum and perichondrium.

With the nasal cavity are associated the **paranasal sinuses**. This is a pneumatic cavity in the flat bones of the skull.

Paranasal sinuses of the horse:

1) ***large maxillary sinus*** *(sinus maxillaris major),* is a large, lateral diverticulum of the lacrimal, zygomatic, maxillary bones and the dorsal turbinate. From a large maxillary sinus protrude rest sinuses.

2) ***small maxillary sinus*** *(sinus maxillaris minor)* is front protrusion of the maxillary bone.

3)***conchofrontal sinus*** *(sinus conchofrontalis)* is a protrusion in the frontal and nasal bones and dorsal turbinate.

4) ***sphenopalatinalsinus*** *(sinus sphenopalatinus)* is a protrusion in the palatine and sphenoid bones.

Paranasal sinuses of the cattle:

1) ***maxillary sinus*** *(sinus maxillaris)*.

2) ***frontal sinus*** *(sinus frontalis)*

3) ***palatinalsinus*** *(sinus palatinus)*.

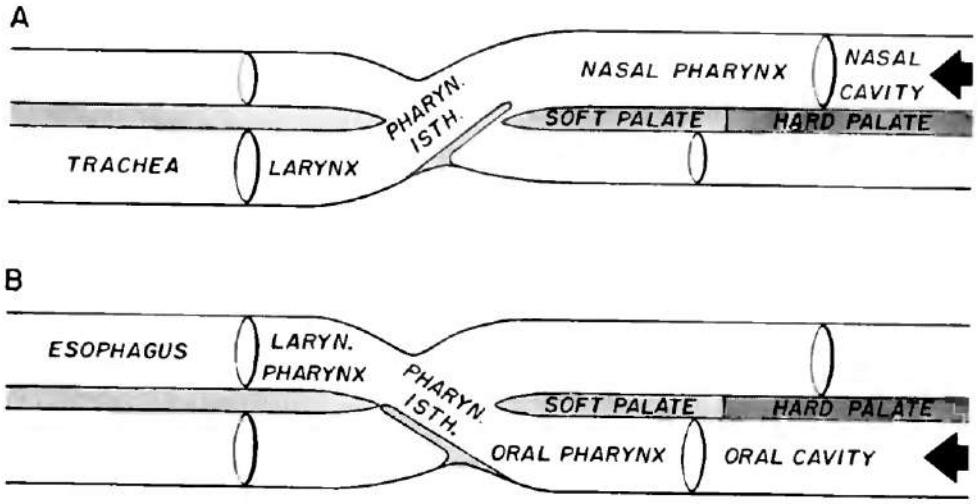
Dog has only ***frontal sinus.***

All paranasal sinuses enlarge with age, and only the largest definitive diverticula are present at birth.

NASAL PORTION OF PHARYNX

The **nasal portion** of the pharynx (pars nasalis pharyngis), also called the **nasal pharynx** or **nasopharynx**, extends from the choanae to the pharyngeal isthmus.

On each lateral wall of the nasal pharynx, above the middle of the soft palate, is an oblique slitlike opening, long, which is the *pharyngeal opening of the auditory tube* (ostium pharyngeum tubae auditivae).



The passageways of pharynx:

- in time inhalation (A)
- in time deglutition (B)

The *auditory tube* (tuba auditiva), or eustachian tube, extends between the cavity of the middle ear and the cavity of the nasal pharynx. It serves to equalize the atmospheric pressure on the two sides of the tympanic membrane.

Nasopharynx and oropharynx are delimited by soft palate and **pharyngeal lymphoid ring** *(anulus pharyngeus).*

The mucous membrane of the nasopharynx is lined with ciliated epithelium and contains **tonsils**.

The muscular tunic forms constrictors and dilators from the striated muscle tissue.

Outer tunic *(adventitia)* is loose connective tissue.

LARYNX

The **larynx** is a short musculocartilaginous tube which connects the pharynx and trachea. It is a complex valvular apparatus, which regulates the volume of air in respiration, prevents aspiration of foreign bodies, and is the chief organ of voice.

The larynx serves for vocalization and prevents the inspiration of foreign material. The larynx is located directly posterior to the root of the tongue and the soft palate. The intrinsic muscles of the larynx control the size of the laryngeal inlet, the size and shape of the glottis, and the positions of the laryngeal cartilages.

Ventrally it is covered by the skin, fascia, and muscles. Laterally it is related to the parotid and submaxillary glands and to the muscles.

It is attached to the body and hyoid bone, and thus indirectly to the base of the cranium.

The middl coat of the wall of the larynx consists of cartilages, connected by ligaments, and moved by extrinsic and intrinsic muscles. The cavity is lined with mucous membrane.

The **cavity of the larynx** (cavum laryngis) is divided into three transverse

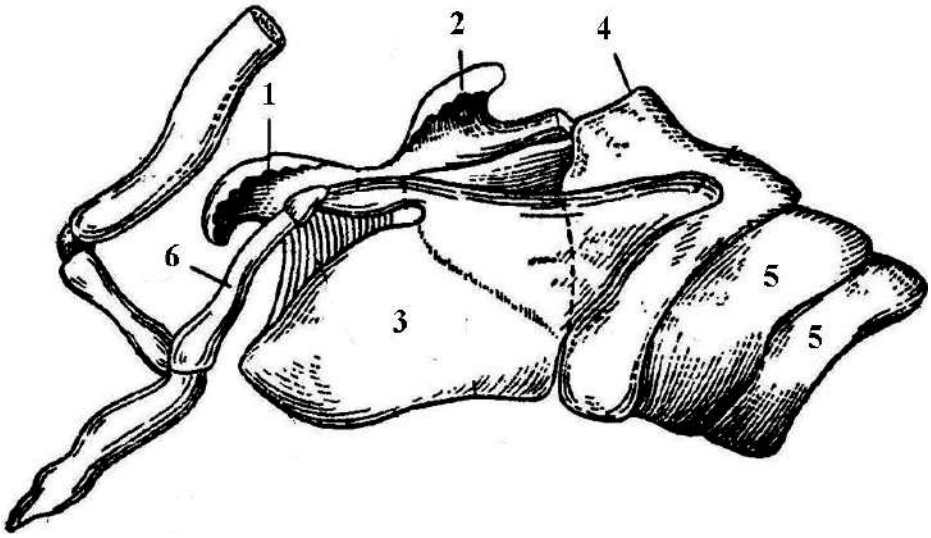
segments: the ***vestibule***, which opens in the pharynx by the aditus laryngis; a middle, narrow portion, called the ***glotti***s; and the ***infraglottic cavity***, which lies caudal to the glottis.

The *laryngeal vestibule* (vestibulum laryngis) extends from the laryngeal opening to the ventricular folds. The *rim of the vestibule* (rima vestibuli) is the caudal opening of the vestibule. The *vestibular* (ventricular) *fold* (plica vestibularis) is a short, wide plica of mucosa, which runs from the expanded ventral margin of the cuneiform cartilage to the cranial dorsal surface of the thyroid cartilage.

The **glottis** consists of the paired arytenoid cartilages dorsally and the paired vocal folds ventrally which form a narrow passageway into the larynx, which is called the ***rima glottidis***. It is separated from the vestibular fold by the slitlike opening of the lateral ventricle. The ***vocal ligament*** (lig. vocale) is a strap of elastic fibers which is enclosed in the vocal fold. The pair **lateral ventricle** of the larynx (ventriculus lateralis laryngis) includes the slight dorsoventral depression between the vestibular and vocal folds, as well as the ***laryngeal saccule*** (sacculus laryngis). The impair**small middle ventricle** (ventriculus laryngis medianus) lies ventrally at the base of the epiglottis.

Cartilages of the Larynx

There are **three** single cartilages and **one** pair**.**



The cartilage of the larynx of horse.
Left aspect.

1 – epiglottis,
2 – arytenoid,
3 – thyroid,
4 – cricoid,
5 – cartilages of trachea,
6 – hyoid bone (greater horn).

The **laryngeal cartilages** (cartilagines laryngis) are the epiglottic, thyroid, cricoid, arytenoid cartilages. Only the arytenoid cartilage is paired.

The **epiglottic cartilage** (cartilago epiglottica) forms the basis of the epiglottis. The **epiglottis** resembles a sharp-pointed spade.

The **thyroid cartilage** (cartilago thyroidea) is the largest cartilage of the larynx. It forms the middle portion of the laryngeal skeleton and is open dorsally.

The **cricoid cartilage** (cartilago cricoidea) is the only cartilage of the larynx which forms a complete ring.

The **arytenoid cartilage** (cartilago arytenoidea) is an irregular cartilage, one on either side, which articulates with the craniodorsal border of the cricoid cartilage.

Laryngeal muscle

I. *Dilatators:*

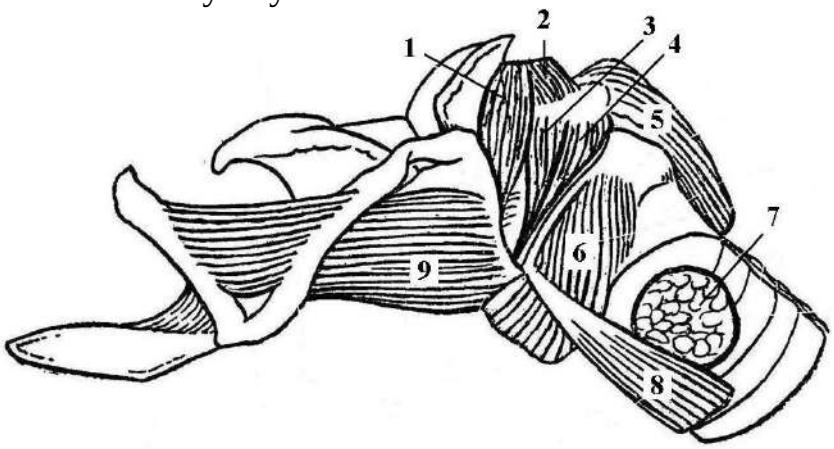
1. m. cricoarytaenoideus dorsalis
2. m. cricothyreoideus
3. m. hyoepiglotticus

II. *Constrictor:*

1. m. cricoarytaenoideus lateralis
2. m. vocalis
3. m. ventricularis
4. m. arytenoideus transversus

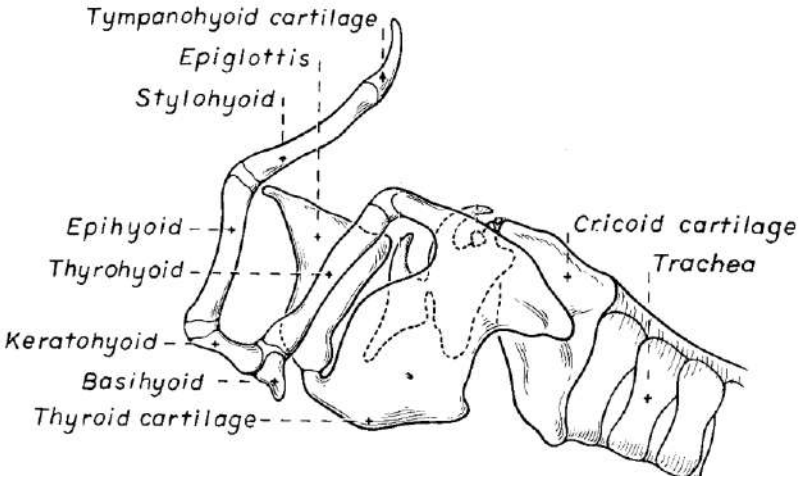
III. Muscles acting on the larynx totally:

1. m. sternothyreoideus
2. m. hyothyreoideus



The muscles of the larynx

1 – ventricularis,
2 – m. arytenoideus transversus,
3 – m. vocalis,
4 – m. cricoarytaenoideus lateralis,
5 – m. cricoarytaenoideus dorsalis,
6 – m. cricothyreoideus,
7 – thyroid gland,
8 – m. sternothyreoideus,
9 – m. hyothyreoideus.



The cartilage of the larynx of dog.
Left aspect.

TRACHEA

The **trachea** is a tube which extends from the larynx to its ***bifurcation*** (bifurcatio tracheae) dorsal to the cranial part of the base of the heart.

Twopartsaredistinguished inthetrachea:

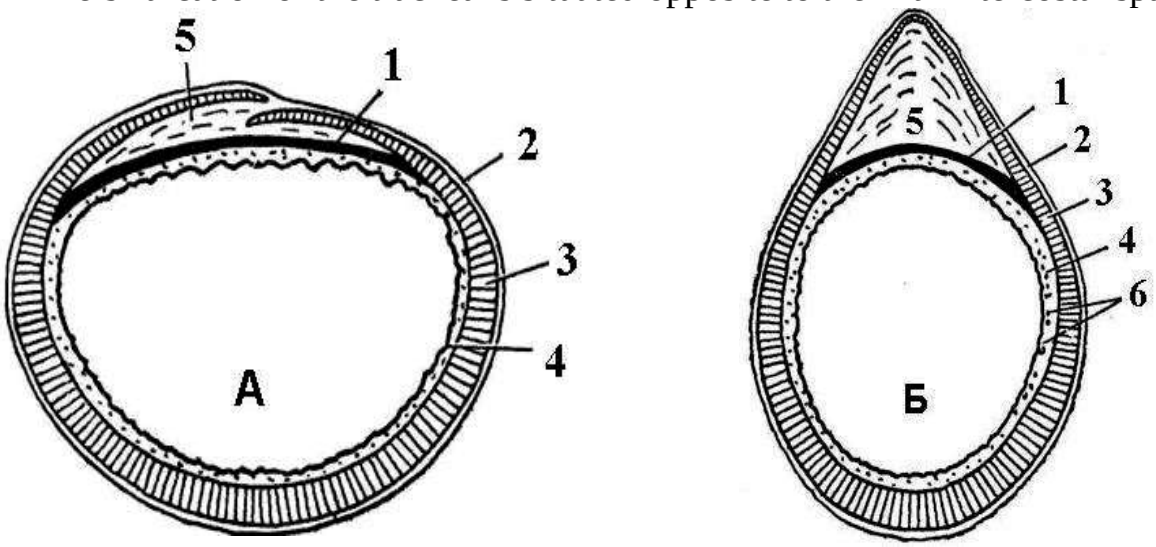
- cervical part – ***pars cervicalis***
- thoracic part – ***pars thoracalis***

The *tracheal cartilages* (cartilagines tracheales) form the skeleton of the trachea. The rings of the tracheaare composed of hyaline cartilage. They are incomplete dorsally, and their free ends are connected dorsally by *tracheal muscle* (musculus trachealis) and connective tissue. The rings so formed are united in a longitudinal direction by the ***annular ligaments of the trachea*** (ligg. anularia trachealia).

In its cervical part the trachea is related dorsally to the oesophagus for a short distance.

The thoracic part of the trachea passes backward between the pleural sacs and divides into the two bronchi over the left atrium of the heart.

The bifurcation of the trachea is situated opposite to the fifth intercostal space.



Transverse section of the trachea

A – horses, B – cattle

1 – tracheal muscle, 2 – adventitia, 3 – tracheal cartilage, 4 – mucosa, 5 – transverse ligament of the trachea, 6 – mucosal shell.

BRONCHI

The two bronchi, right and left (bronchus dexter et sinister), are formed by the bifurcation of the trachea. Each passes backward and outward to the hilus of the corresponding lung. Their structure is similar to that of the trachea.

BRONCHIAL TREE

The **bronchial tree** begins at the bifurcation of the trachea by the formation of the right and left ***main bronchi*** (bronchi principales). Each main bronchus divides into ***lobar bronchi*** (bronchi lobares). Within the lobe of the lung the lobar bronchi divide into *segmental bronchi* (bronchi segmentales), which are sometimes referred to as tertiary bronchi. The segmental bronchi and the lung tissue which they ventilate are known as ***bronchopulmonary*** *segments* (segmenta bronchopulmonalia). Adjacent bronchopulmonary segments normally communicate with each other.

The segmental bronchi usually branch dichotomously into small bronchi,

which have been referred to as subsegmental bronchi. This process of branching continues until the **respiratory bronchioles** are formed. The *respiratory bronchioles* (bronchuli respiratorii) give rise to *alveolar ducts* (ductuli alveolares), *alveolar sacs* (sacculi alveolares), and *pulmonary alveoli* (alveoli pulmonis).

LUNGS

The **lungs** (left and right)*(pulmo dexteret sinister)* are the parenchymal organs in which oxygen from the atmosphere and carbon dioxide from the blood are exchanged. The lungs serve a passive function in the mechanical act of respiration. Gas exchange occurs due to a large area of contact between the airway and the bloodstream.

The diaphragm and several segmental muscles which are attached to the ribs, when they contract, bring about an increase in the size of the thoracic cavity, and thus air is drawn into the lungs because of the negative pressure which is produced. Aiding in expulsion of the air from the lungs are the abdominal muscles, which contract and force the abdominal viscera against the caudal surface of the diaphragm.

Two **lungs** (pulmo sinister et dexter) possess many features in common. Each has a slightly concave **base** (basis pulmonis), which lies adjacent to the diaphragm, and an **apex** (apex pulmonis), which lies in the thoracic inlet.

There are distinguished following *surface s*on lungs:

- costal – ***facies costalis***
- diaphragmatic – ***facies diaphragmatica***
- mediastinal – ***facies mediastinalis***
- pericardiac – ***facies pericardialis***

The curved lateral surface of each lung is called the ***costal surface***, and the flattened surface which faces the opposite lung is called the ***mediastinal s****urface.*

There is **hilus of the lung** *(hilus pulmonis)*on the mediastinal surface. It is the area of each lung which receives the bronchi and furnishes passages for the pulmonary and bronchial vessels and nerves.

Through them into the lung are entered the main bronchus *(bronchus principalis),* main pulmonary trunk *(truncus pulmonalis),*nerves. From hilum are escaped pulmonary veins *(venae pulmonales)* and lymphatic vessels *(vasa lymphatica).*

The ***root of the lung*** (radix pulmonis) consists of the aggregate of those structures which enter the organ at the hilus.

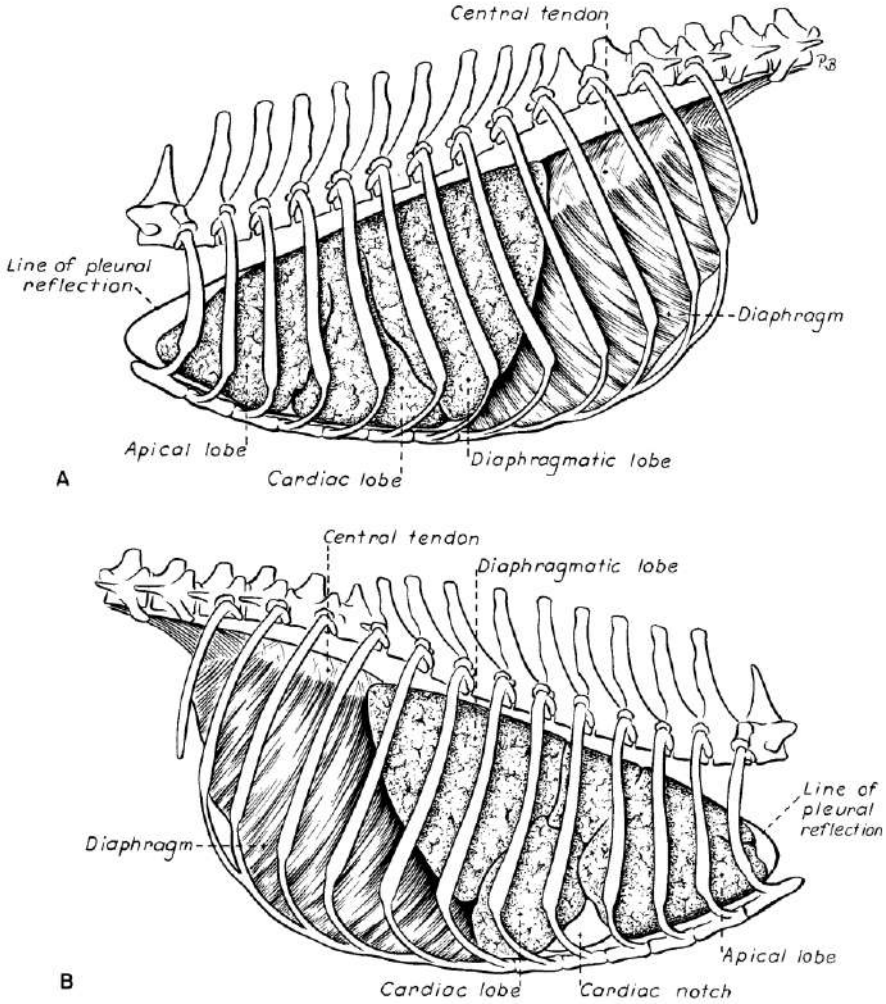
The ***diaphragmatic surface*** (facies diaphragmatica) is concave, because it lies against the convex surface of the diaphragm. The ***costal surface*** of each lung is continuous with the medial surface at an acute angle ventrally.

This margin, extending from the apex to the base of the lung, is called the ***ventral border of the lung*** (margo ventralis pulmonis). Caudally, the ventral margin of the lung is continuous with the peripheral border of the base of the lung, or the ***basalborder***(margobasalis).

Outside the lungs are covered by pulmonary pleura *(pleura pulmonalis)*, which is a derivative of the visceral pleurae.

Between the visceral and parietal pulmonary pleurae is the pleural cavity (*cavum pleuralis).*

Each lung is divided down to its root by the ***oblique fissure*** (fissura obliqua).



Thoracic cage and lungs
A – left side, B – right side

Left lung has following lobes:

- ***apical lobe of the left lung***
  (pulmo sinister, lobus apicalis)
- ***cardiac lobe of the left lung***
  (pulmo sinister, lobus cardiacus)
- ***diaphragmatic lobe of the left lung***
  (pulmo sinister, lobus diaphragmaticus)

Right lung has following lobes*:*

- ***apical lobe of the right lung***
  (pulmo dexter, lobus apicalis)
- ***cardiac lobe of the right lung***
  (pulmo dexter, lobus cardiacus)

- ***diaphragmatic lobe of the right lung***
  (pulmo dexter, lobus diaphragmaticus)
- ***accessory lobe of the right lung***
  (pulmo dexter, lobus accessorius)

P U L M O N A R Y P A R E N C H Y M A is formed by two parts: airways – bronchial tree *(arbor bronchialis)* and respiratory – alveolar tree *(arbor alveolaris).*

The main bronchus forming a bronchial tree.

Depending on the diameter and structure of the wall the bronchi are distinguished:

- large calibre (segmental bronchi of the lungs)
- medium calibre
- small calibre
- bronchioles (*bronchuli)*, their diameter is about 1 mm

Bronchus of small caliber is divided into 2 bronchioles, each of which is divided into 20-30 terminal bronchioles.

Terminal bronchioles *(bronchuli terminalis)* is an elements of bronchial tree.

A L V E O L A R T R E E *(arbor alveolaris)* begins from the branching of terminal bronchioles. Terminal bronchiole is divided into 2-3 **respiratory bronchioles** (***bronchuli respiratorii),*** those in turn into 3-4 alveolar ducts (***ductuli alveolares)***, each of which ends with two alveolar sacs (***sacculi alveolares)***.

The functional unit of the lung is **acinus** (***acinus pulmonis).*** It isbranching of a respiratory bronchiola.

Alveolus are located in walls of respiratory bronchioles, alveolar ducts and sacs.

Alveole *(alveoli pulmonis)* is a thin-walled vesicle, 0.1 mm in diameter. It has a wide opening which open into the cavity of the respiratory part of lung.

The wall of the alveoli is constructed from one layer of respiratory alveolates, covered by a surfactant. The surfactant is a substance that prevents the alveoli from sticking together.

For example, horses have 5000 million alveoli of the lungs, and the area of their respiratory surface of the pulmonary alveoli is 500 m^2.

S T R O M A O F L A N G S is a connective tissue containing much elastic fibers. There are there nerves, airway, branch the pulmonary artery and vein, bronchial artery and vein, lymphatic vessels. The connective tissue, that accompanies the bronchi, contains lymphoid nodules.

A large amount of elastic tissue gives the lungs elasticity, so that they fall off after opening the thoracic cavity. Hence it becomes clear that the lungs can function only with the participation of inspiratory muscles.

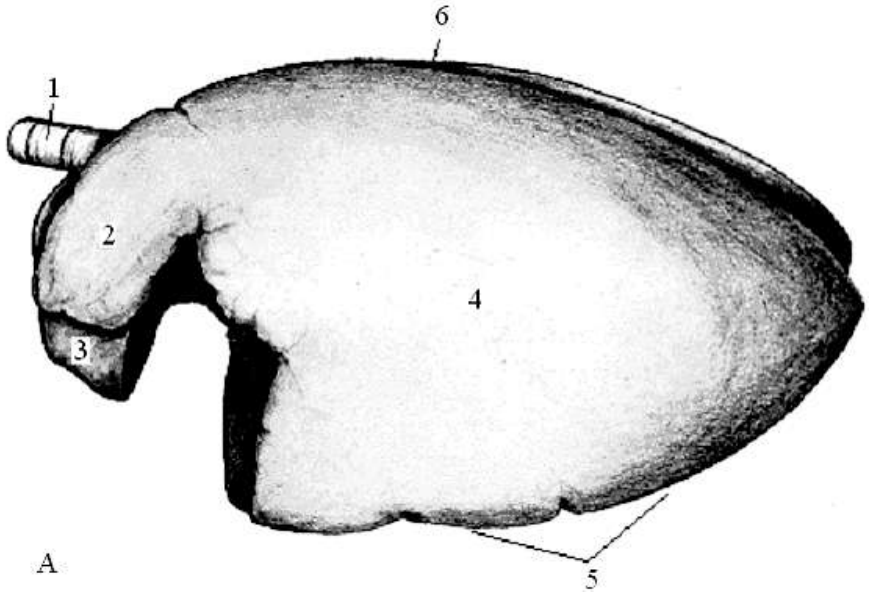
Functional vessels of the lungs form a pulmonary (small) circle of blood circulation. For gas exchange, venous blood enters the lung from the right ventricle of

the heart through the pulmonary artery. Oxygenated arterial blood is collected in pulmonary veins and return into the left atrium.

Species features of lungs

Horse:

1. The lungs surface is smooth.
2. Cardiac and diaphragmatic lobes are fused into one **cardio-diaphragmatic** lobe**.**

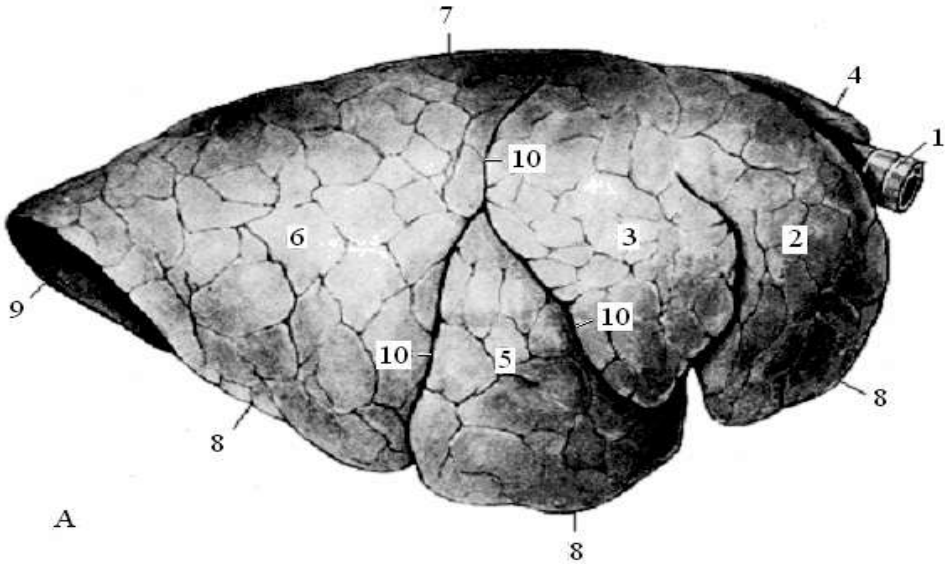


Lung of the horse.
Left aspect.

1 – trachea;
2 – left apical lobe;
3 – right apical lobe;
4 – cardiacodiaphragmatic lobe;
5 – ventral (acute) margin;
6 – dorsal margin

Cattle:

1. The lungs surface has a clearly expressed pattern in form of cells.
2. The eparterial (tracheal) bronchus is departed from trachea to apical lobe of right lung.
3. The apical lobe of right lung is divided into the cranial and caudal portions.



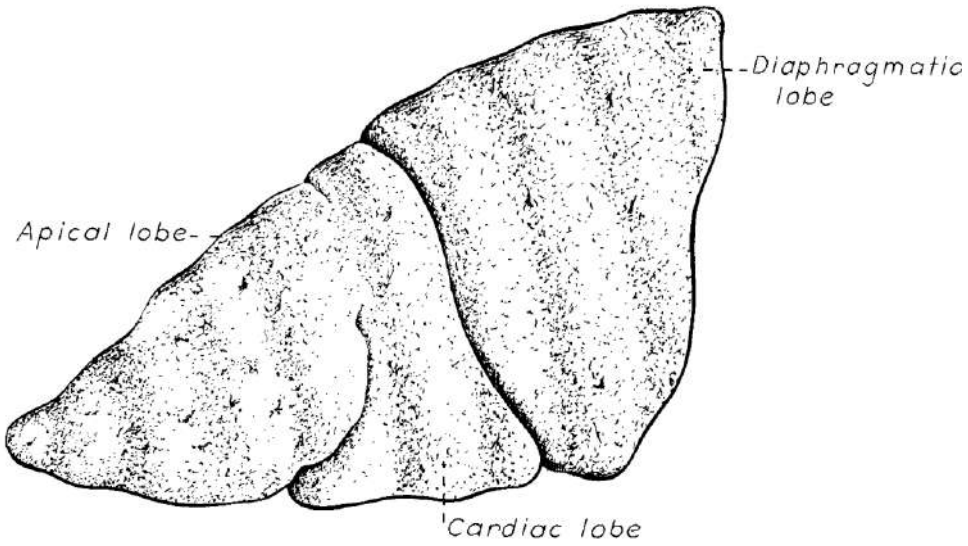
Lung
of cattle.

Right aspect.

1 – trachea; 2 – cranial portion of the right apical lobe; 3 – caudal portion of the right apical lobe; 4 –left apical lobe; 5 *–cardiac lobe***;***6 – diaphragmatic lobe*; *7 – dorsal margin; 8 – ventral (acute) margin; 9 – diaphragmatic surface; 10 – interlobular fissure.*

Dog:

1. Interlobar incisures are deep and achived the lung root**.**
3. All lobes are large.



Left lung of dog.

Basics of respiratory mechanism

To obtain a clear understanding of the lungs and how they function passively in the mechanical act of breathing, it is necessary first to understand the **respiratory biomotorics**.

It is includes:

1. Muscle-inspirators increase the chest volume. The diaphragm pushes the abdominal organs and increases the depth of the thoracic cavity.

2. The pulmonary pleura grows to the lungs, and the rib and diaphragmatic pleura grows to the walls of the thoracic cavity. The paired pleural cavity is hermetically sealed. With the expansion of the thorax under the influence of the muscles, the lungs are stretched due to the sucking action of negative pressure in the pleural cavities, while air is sucked into the lungs in time inhalation.

3. The walls of the acinus elements (respiratory bronchioles, alveolar ducts and sacs) have alveoli. The wall of the alveoli consists of a single layer of ***respiratory epithelium***. Each alveolus is braided by numerous blood capillaries, the wall of which consists of a single layer of **endothelial** cells. The barrier between air and blood is very small and does not exceed 0.3-0.5 mm.

4. Gas exchange is carried out by diffusion due to the difference in the partial pressures of oxygen and carbon dioxide in blood and air of the lungs. At the same time, O_2 enters the capillaries lumen, where it combines with erythrocytes, and CO_2 of venous blood enters the alveoli lumen.

5. The act of respiration is semireflective. You can delay or speed up your breathing, but only for a while.

6. Inspiration is an active act, expiration is a passive act. Expiration act takes place with the participation of muscle-expirators, which, reduce the volume of the chest cavity and facilitate the expulsion of air from the lungs.

UROGENITAL APPARATUS

The **urogenital apparatus** (apparatus urogenitalis) includes two groups of organs, the **urinary** organs and the **reproductive** organs.

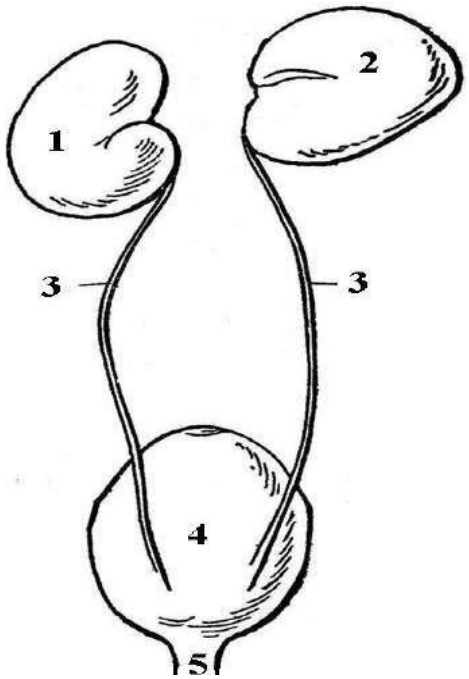
The **urinary organs** elaborate and remove the chief excretory fluid, the urine.

The **genital organs** serve for the formation, development, and expulsion of the products of the reproductive glands. In the higher vertebrates the two apparatus are independent except at the terminal part, which constitutes a urogenital tract, and includes the vulva in the female and the greater part of the urethra in the male.

URINARY APPARATUS
APPARATUS UROPOETICA

ANATOMICAL COMPOSITION OF URINARY APPARATUS

1. Kidney – *ren, s. nephros*
2. Ureter– ureter
3. Urinary bladder – *vesica urinaria, s. cystis*
4. Urethra (*male urethra* or *female urethra*) – urethra
5. Urogenital canal – *canalis urogenitalis* (in male)
Vestibule of vagina – *vestibulum vaginae* (in female)



The urinary organs

1 – left kidney
2 – right kidney
3 – ureters
4 – urinary bladder
5 – urethra

KIDNEYS

The kidney has:

surfaces:

- dorsal – facies dorsalis
- ventral – facies ventralis

poles:

- cranial – extremitas cranialis
- caudal – extremitas caudalis

borders:

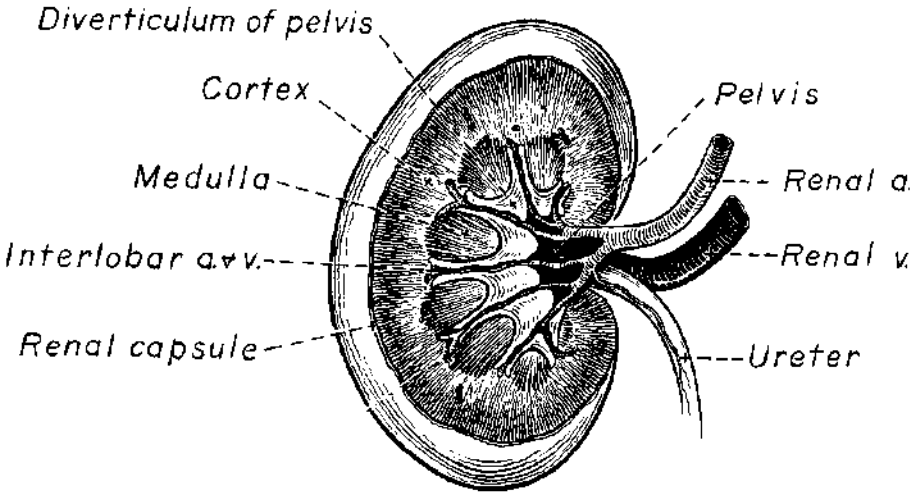
- lateral – margo lateralis
- medial – margo medialis

The **kidneys** (renes) are reddish brown, paired, compound tubular glands that secrete the urine. They are characteristically bean-shaped, and each presents two extremities, two borders, and two surfaces. The ***cranial*** and ***caudal poles*** are joined by a convex ***lateral border*** and a straight ***medial border***. The medial border is indented by an oval opening, the hilus, which opens into a space, the ***renal sinus***. The hilus transmits the ureter, renal artery and vein, lymph vessels, and nerves. Of these structures, the renal artery is the most dorsal, and the renal vein the most ventral. The nerves and lymphatics lie in close relationship to the vein.

Both kidneys are *retroperitoneal*, located in the sublumbar region. The dorsal, or parietal, surface of each kidney is less convex than the ventral, or visceral, surface. The dorsal surface is in partial contact with the areolar tissue underlying the sublumbar muscles, whereas the entire ventral surface is covered by peritoneum.

Both kidneys are invested with a ***fibrous capsule***, are embedded in ***adipose tissue***. A strong, thin fibrous capsule (capsula fibrosa) covers the surface of the kidney.

Each kidney is covered with peritoneum only with here ventral surface.



The longitudinal section of kidney

The ***renal sinus*** (sinus renalis) is the cavity of the kidney. Its opening on the medial border of the kidney is called the ***renal hilus*** (hilus renalis). The sinus contains the renal pelvis, a variable amount of adipose tissue, and branches of the renal artery, vein, lymphatics, and nerves. After they pass through the sinus, the vessels and nerves enter the parenchyma of the kidney.

The ***renal pelvis*** (pelvis renalis) is a funnel-shaped, saclike structure that collects mine from the collecting ducts of the kidney. Urine is mixed in the pelvis before it passes on into the ureter.

Structure

The parenchyma of the kidney is made up of an internal renal *medulla* (medulla renis) and an external *cortex* (cortex renis). When the kidney is cut longitudinally, the medulla appears striated. The portion of the medulla closest to the renal sinus and projects into the renal pelvis.Transverse, curved secondary ridges project from each side of the renal papilla. These are in contact with the renal pelvis. The ***pyramid***, from which the renal papilla projects, is marked with fine striae. These ***striations*** are formed by the ***renal tubules***. The renal papilla is marked on its intrapelvic surface by a variable number of foramina, which are the openings of the ***papillary ducts***. These ducts carry urine into the renal pelvis.

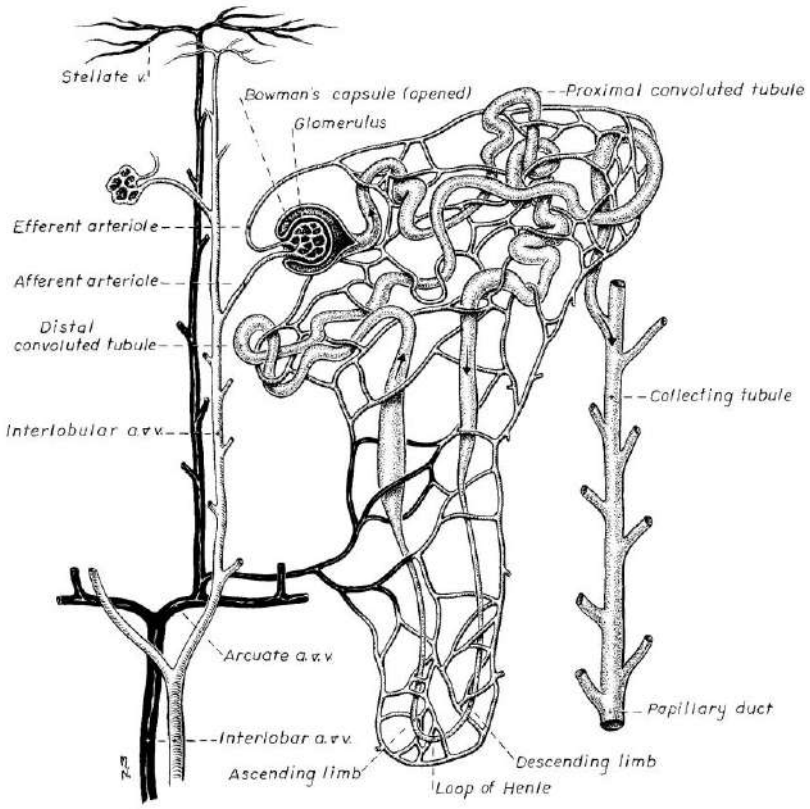
The sectioned peripheral portion of the renal parenchyma, the cortex, is granular in appearance owing to the presence of renal corpuscles and convoluted tubules.

Renal tubules (tubuli renales)

The ***nephron*** composed of a ***renal corpuscles*** and a portion of straight ***tubules*** (tubuli renale rectus) is the **unit of urine production**.

The double-layered *glomerular capsule* begins the renal tubule. It is invaginated by a spherical confluence of blood capillaries, the glomerulus.

The **glomerulus** and **capsule** together form the renal (malpighian) **corpuscle**. Renal corpuscles are present in the renal cortex, but not in the medulla.



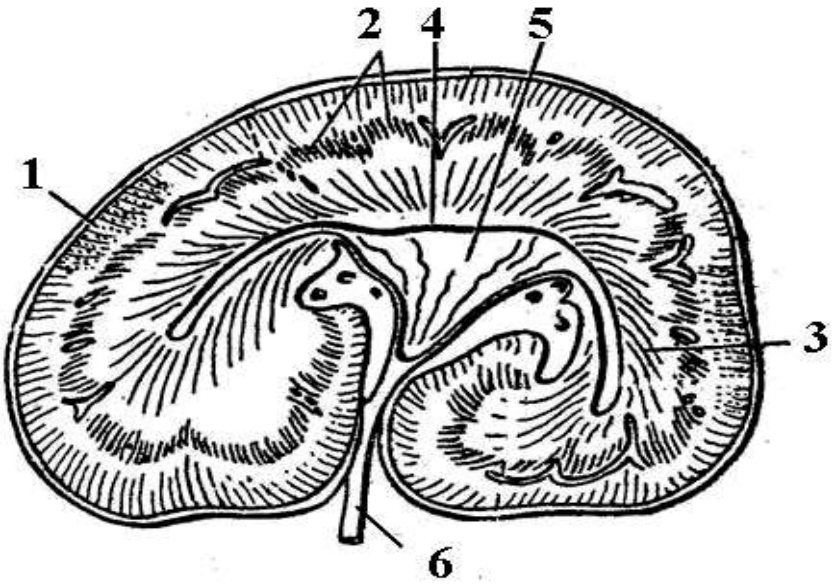
Scheme of vessels and tubules of structural unit of kidney

From each glomerular capsule (capsula glomeruli), the ***proximal convoluted tubule*** descends toward the medullary portion of the kidney through the pars convoluta (peripheral region of the cortex) to the pars radiata, where it straightens out as the descending limb of Henle's loop.

This narrow tube extends into the medullary pyramid. After progressing downward for a variable distance, it makes a U-tum and again runs peripherally, increases in diameter, and becomes the ascending limb of Henle's loop. It now reaches the pars convoluta as the ***distal convoluted tubule***.

After further twisting and coiling, it extends into the pars radiata and opens into a straight ***collecting tubule*** along with other distal convoluted tubules. The collecting tubule runs through the medulla, united with other collecting tubules, and opens onto the crest of the renal papilla as a ***papillary duct*** (ductus papillaris).

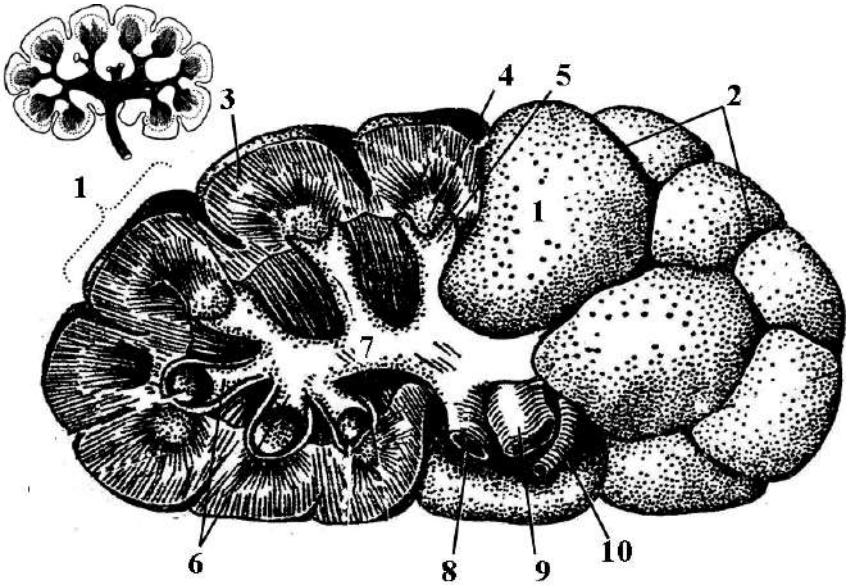
Species features of the lungs



Kidney of the horse

1 – cortex,
2 – intermediate zone
3 – medulla,
4 – papilla,
5 – renal pelvis,
6 – ureter

The **kidney of the horse** is not papillated.



Kidney of cattle

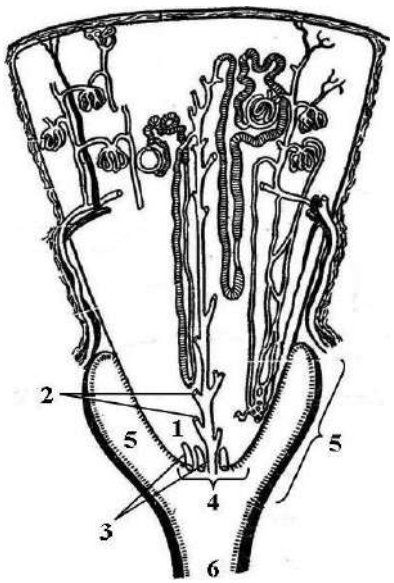
1 – kidney lobule, 2 – kidney fissures, 3 – cortex, 4 – renal papilla, 5 – renal calyx, 6 – renal stalk, 7 – renal duct, 8 – ureter 9 – renal a., 10 – renal v.

The **kidneys of the cattle** are superficially divided into polygonal lobes by fissures of variable depth. The fissures arc filled with fat.

The right kidney has an elongated elliptical outline, and is flattened dorso-ventrally.

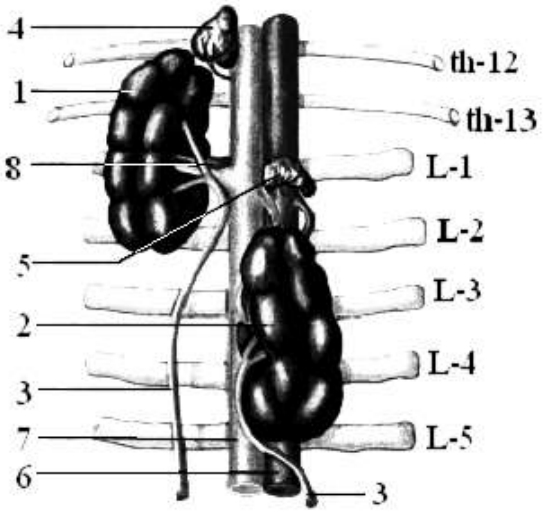
The **left kidney** occupies a remarkable position, and when hardened *in situ*, differs strongly in form from the right one. When the rumen is full, it pushes the kidney backward and across the median plane, so that it is situated on the right side, behind and at a lower level than the right kidney. It then lies under the third-fifth lumbar vertebrae. When the rumen is not full, the left kidney lie partly to the left of the median plane.

The **kidneys of the sheep** are bean-shaped and smooth, without any superficial lobation. When the rumen in full, the left kidney (which is attached by a short mesentery) usually lies entirely to the right of the median plane.

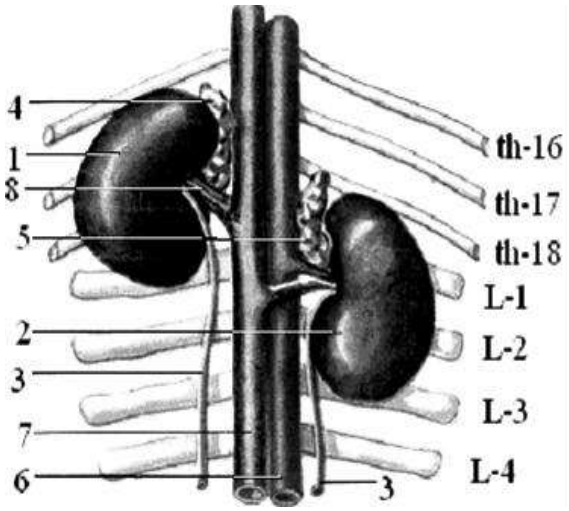


The pyramid of the kidney of cattle

1 – renal papilla, 2 – collective tube, 3 – papillary duct, 4 – foramina of papilla, 5 – renal calyx, 6 – stalk



Cattle



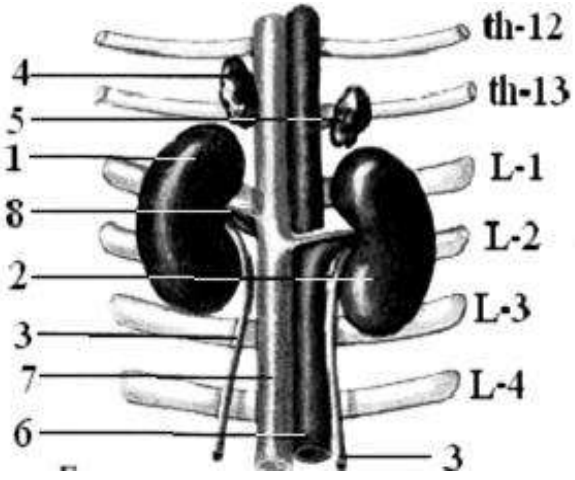
Horse

The position of the kidneys relative to the skeletal segments

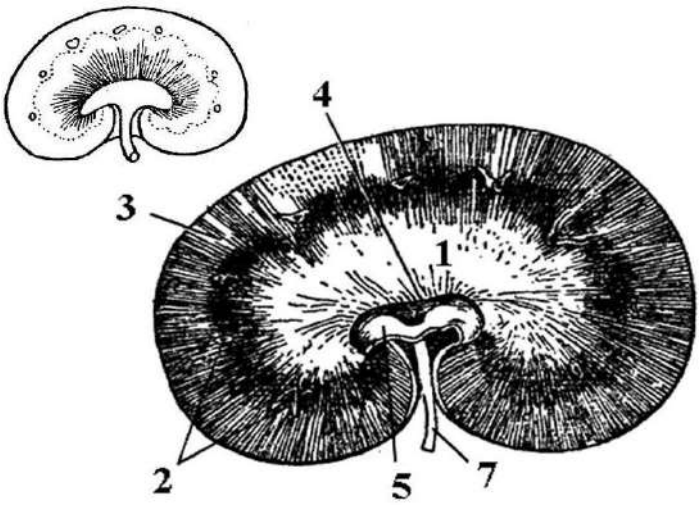
The view from the side
of the abdominal cavity

XII – XVIII th – thoracic segments
I – VI L – lumbar segments

1 – right kidney, 2 – left kidney, 3 – ureter, 4 – the right adrenal gland, 5 – left adrenal gland, 6 – caudal v. cava, 7 – abdominal aorta, 8 – renal a.



Dog



Kidney of the dog

1 – cortex,
2 – intermediate zone
3 – medulla,
4 – papilla,
5 – renal pelvis,
6 – ureter

URETER

The **ureter** is muscular, slightly flattened tubes that carry urine from the kidneys to the bladder.

The ureter begins at the renal pelvis, which receives urine from the common renal papilla. Running caudoventrally and medially toward the urinary bladder, the ureters enter the bladder obliquely and open by means of two slitlike orifices.

The **ureter** includes **abdominal part** (pars abdominalis) and **pelvic part** (pars pelvina).

The wall of the ureter is composed of ***three*** coats. The outer is **serosus coat** (tunica serosa). The **muscular coat** (tunica muscularis) consists of inner and outer layers of longitudinal fibers, with a stratum of circular fibers between them. The **mucous membrane** (tunica mucosa) is covered with transitional epithelium.

URINARY BLADDER

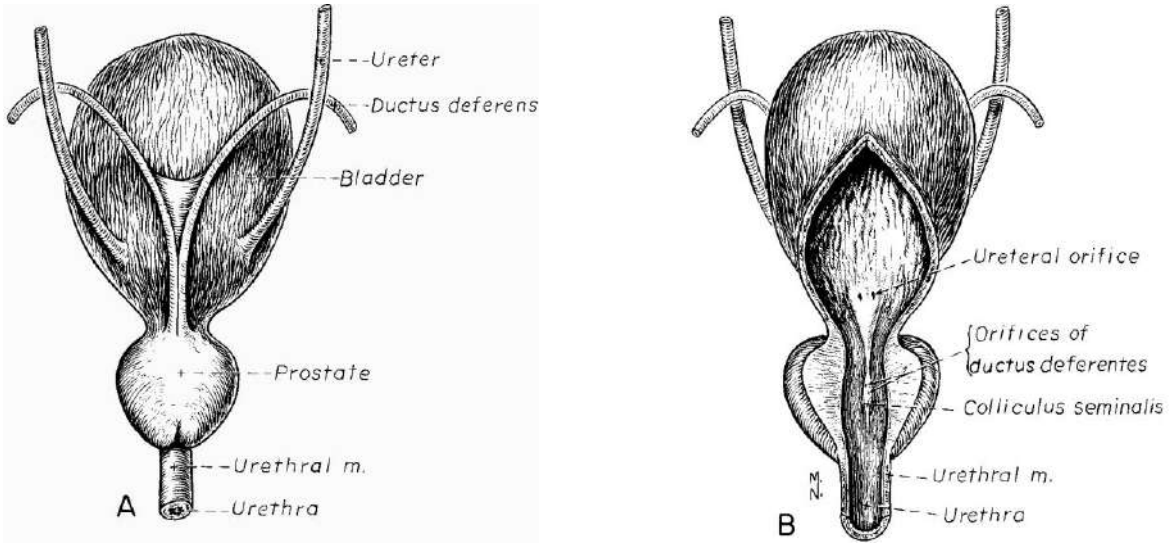
The ***urinary bladder*** (vesica urinaria, s. cystos) is a organ that receives urine from the kidneys, through the ureters, and stores it until it is disposed of through the urethra.

The bladder may arbitrarily be divided into an **apex** (apex vesicae), a **body** (corpus vesicae),and a **neck** (cervix vesicae) connecting with the urethra. When empty, the bladder lies entirely, or almost entirely, within the pelvic cavity.

The **mucous coat** of the urinary bladder, like that of the ureter, is made up of transitional epithelium. It is irregularly folded when the bladder is empty. The mucosa forms numerous folds when the organ is empty and contracted.

From each **ureteral orifice** (ostium ureteris) a fold of mucous membrane (plica ureterica) passes backward and inward, uniting with its fellow to form a ***median crest*** (crista urethralis) in the first part of the urethra and boundaries of the **triangle** of urinary bladder ***(trigonum vesicae)***. The apex of the triangle is at the urethral orifice, and the base is indicated by a line connecting the ureteral openings. The **internal**

urethral orifice (ostium urethrae internum) lies at the apex of the triangle behind the ureteral orifices.



The urinary bladder of the dog
A – dorsal aspect, B – ventral aspect

There are **three layers** of muscle in the wall of the urinary bladder, similar to the arrangement of muscle fibers in the ureter: outer and inner longitudinal layers, and a relatively thick middle circular layer. The muscle fibers all take on an oblique or circular appearance at the urethral-bladder junction, forming a sphincter.
In the male, the sphincter lies deep to the prostate gland.

The reflections of the peritoneum from the lateral and ventral surfaces of the urinary bladder to the lateral walls of the pelvis and to the ventral abdominal wall are known as **ligaments** of the bladder.

These are made up of double layers of peritoneum. The largest peritoneal fold, the ***middle ligament*** (lig. vesicae medianum), or middle ligament of the bladder, is reflected from the ventral surface of the bladder to the symphysis pelvis. The middle ligament in the fetus contains the urachus (stalk of the embryonic allantois). This normally disappears shortly after birth, leaving only the peritoneal fold. Even in the adult, a vestigial fibrous urachus may sometimes be found in the free edge of the ligament.

The ***lateral ligaments*** of the bladder(ligg. vesicae laterales) connect the lateral surfaces of the bladder to the lateral pelvic walls. Before birth, the bilateral umbilical arteries carry blood from the fetus to the placenta and are components of the umbilical cord. When the cord is severed at birth, the arteries retract and become fibrous cords between the bladder and the umbilicus.

URETHRA

The ***urethra*** is a tubeshape organ that is located in pelvic cavity. It begins from neck of the bladder. In *male* is continuated into urogenital canal after orifices of the ***colliculi seminalis.*** In *female*urethra is finished by external orifice into vestibule of the vagine. Both the male and the female urethra are discussed in connection with the genital organs, with which they are inseparably associated.

FEMALE GENITAL ORGANS
ORGANA GENITALIA FEMININA

ANATOMICAL COMPOSITION OF THE *FEMALE GENITAL ORGANS*

The **female genital organs** consist of:

1. ***Ovary*** *– ovarium, s. oophoron*
2. ***Uterinetuba (oviduct)****– tuba uterinae, s. salpinx*
3. ***Uterus****– uterus, s. metra*
4. ***Vagina****– vagina, s. kolpos*
5. ***Vestibule of vagina****– vestibulum vagina*
6. ***Pudendum (vulva)*** *– pudendum femininum s. vulva*

The ovaries produce the female sex cells (ova), which are transported by the oviducts (uterine tube) to the uterus. There are implantation takes place, if fertilization has occurred, and the embryo is developed. The vagina is a canal leading from the uterus to the external genitalia, the vulva.

BROAD LIGAMENTS

The ovaries, oviducts, and uterus are attached to the dorsolateral walls of the abdominal cavity and to the lateral walls of the pelvic cavity by paired double folds of peritoneum called the right and left broad ligaments (*plicae latae uteri).* Each broad ligament contains an ovary, oviduct, and uterine horn.

The broad ligament is attached dorsally along or near the junction of the psoas and transversus abdominis muscles. Cranially, it is attached by means of the suspensory ligament of the ovary to the junction of the middle and distal thirds of the last rib. The ligament is reflected off the vagina onto the rectum dorsally, ventrally onto the urethra and bladder, and in a curved line laterally onto the wall of the pelvic cavity as far as the internal inguinal ring. A peritoneal fold arises from the lateral surface of the broad ligament and extends from the ovary to (or through) the inguinal canal. It contains the round ligament of the uterus in its free border. The peritoneal extension of the broad ligament through the inguinal canal known as the **vaginal process**, corresponds to the peritoneal outlet (vaginal tunics) into the scrotum of the male.

Morphologically, the broad ligament is divided into three regions: ***mesovarium, mesosalpinx,*** and ***mesometrium***.

The **mesovarium** is that part of the broad ligament which attaches the ovary to the abdominal wall.

The **mesosalpinx** curves around the uterine tube. Boht of these form the ***ovarian bursa***.

The **mesometrium** begins at the cranial edge of the uterine horn, where it is continuous with the mesovarium, and extends caudally to a point where the

peritoneum of the broad ligament reflects onto the bladder. It leaves the uterine horn, the body of the uterus, the cervix, and part of the vagina to attach along the abdominal and pelvic walls.

OVARY

The **ovary** (ovarium), or female gonads, are paired oval organs, located in the abdominal cavity caudal to the kidneys. They are the sites of ova formation and development of certain hormones.

In its normal position, an ovary may be described as having:

- tubal and uterine ends
- free and mesovarian borders
- medial and lateral surfaces

The mesovarian border and medial surface of the ovary are in contact with the **mesovarium**, whereas the dorsal surface and lateral border, free of an intimate peritoneal covering, face the mesosalpinx across the ovarian bursa.

Ligaments

In addition to the mesovarium, the ovary has two ligamentous. The ***suspensory ligament of the ovary*** (plica suspensoria ovarii) is attached cranially to the middle and ventral thirds of the last one or two ribs. The ***proper ligament of ovary*** (ligamentum ovariiproprium) attaches to the cranial end of the uterine horn. There it is continuous with the round ligament of the uterus.

Structure

The ovary is divided into a **medulla** and a **cortex**. The medulla or vascular zone (zona vasculosa) contains blood vessels, nerves, lymphatics, smooth muscle fibers, and connective tissue fibers. The cortex consists of a connective tissue stroma which contains a large number of **germ cells**, **primary ovarianfollicles**, and **vesicular ovarian follicles**. The interstitial cells are modified stroma cells of connective tissue.

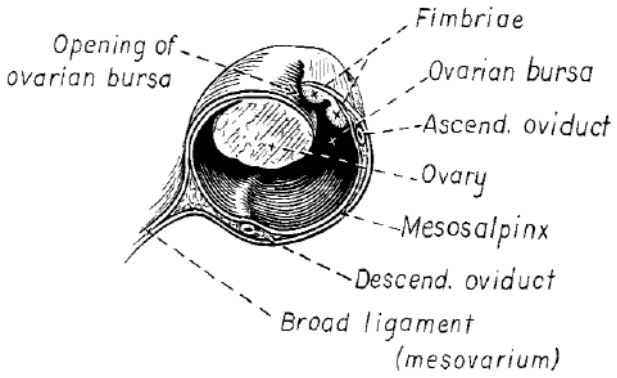
The connective tissue condenses to form the **tunica albuginea** on the periphery of the ovary. The tunica albuginea is covered by **superficial (germinal) epithelium**. The surface of the ovary is **free** of serosa.

New ova are formed from the germinal epithelium at each estrus. Huge numbers of follicles degenerate and become atretic. A vesicular follicle is composed of a number of cell layers. It envelops a cavity filled with follicular fluid. As the follicular fluid increases, the follicle migrates to the periphery of the ovary. When the follicle is under considerable tension by pressure of the fluid, it ruptures, and the ovum comes to the surface of the ovary.

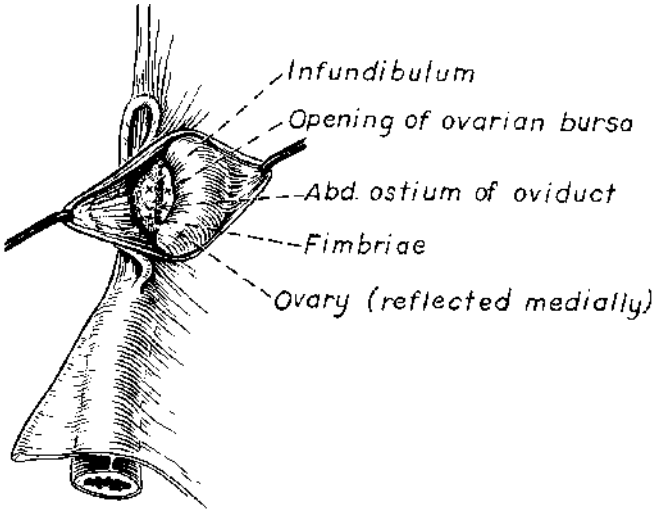
After ovulation, slight hemorrhage occurs, filling the follicular cavity. As this is resorbed, the corpus luteum (yellow body) is quickly formed. If fertilization does not take place, the corpus luteum gradually degenerates into a connective tissue scar. If the ovum is fertilized, the corpus luteum remains fully developed throughout

pregnancy. After parturition, it regresses. Involution of the corpus luteum again allows vesicular follicles to mature.

The ovaries of the **dog** are completely closed in the ***bursa*** which has a narrow slit in its ventromedial surface, through which connecting with the peritoneal cavity.



Section through ovary and ovarian bursa.



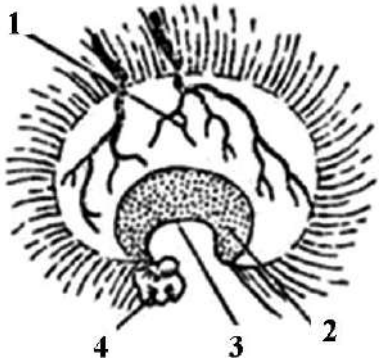
Left ovary and ovarian bursa. Ovarian bursa opened. Dorsal aspect.

The ovaries of the **mare** are bean-shaped, their size varies much in different subjects.

The greater part of the surface of the ovary has a ***covering of peritoneum***. The peritoneal investment is absent at the area of ***ovulation fossa*** and is covered by a layer of columnar cells, a remnant of the germinal epithelium.

Medulla of the ovary are concentrated near the ovulation fossa. So, ovulation takes place in the mare only at the ovulation fossa.

The ovaries of the **cow** are much smaller than those of the mare. They are oval in form, pointed at the uterine end, and have no ovulation fossa.



Scheme of the ovary of the mare

1 – vascular zone
2 – parenchymal zone
3 – ovulation fossa
4 – infundibulum of the oviduct

The greater part of the surface of the gland is covered with germinal epithelium, the peritoneum being limited to a narrow zone along the attached border. Follicles of various sizes are often seen projecting from the all surface, as well as corpora lutea.

UTERINE TUBE

The **uterine tube or oviduct** (tubae uterinae, s.salpinx) transport the ova to the uterus. Each oviduct is located between the peritoneal layers of the mesosalpinx and connects the peritoneal cavity with the uterine cavity. The ovarian extremity of the duct, the **infundibulum**, is located near the edge of the opening into the ovarian bursa. The infundibulum is a funnel-shaped dilatation of the lumen of the oviduct, which narrows into a minute opening, the **abdominal ostium**. This is the origin of the tubal portion of the oviduct. The edges of the infundibulum are fringed by numerous diverging, finger-like processes, the **fimbriae**. Fimbriae are usually visible projecting out of the opening of the ovarian bursa. They are cilia-like in function, creating a current which serves to draw the ova into the abdominal ostium of the oviduct. This tends to decrease the chance of ova escaping into the major peritoneal cavity.

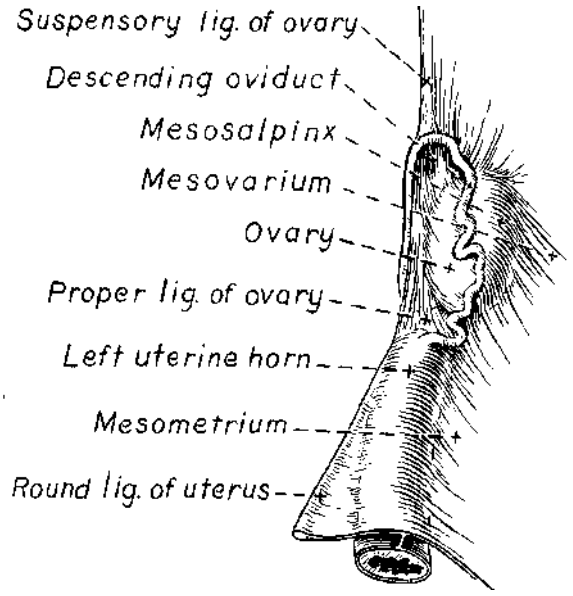
From the abdominal ostium, the uterine tube runs caudolaterally.At the middle of the ovary it curves toward the apex of the uterine horn, where it terminates. The opening of the oviduct into the horn of the uterus is called the **uterine orifice** of the uterine tube.

Thus in the uterine tube are distinguished:

- **infundibulum**of the tubae uterinae, the edges of which form a fimbria tubae. At the infundibulum is the **abdominal orifice** of the oviduct (ostium abdominale tubae uterinae)
- **ampulla** (ampulla tubae uterinae) is the average convoluted part
- **isthmus** (isthmus tubae uterinae) is ending narrowed part, which opening in the cavity of the uterine horn by the **uterine orifice** (ostium uterinum tubae)

Ova are moved down the oviduct toward the uterus principally by peristaltic movements rather than by action of cilia. Fertilization, the union of ovum and sperm, normally takes place in the infundibulum. The oviduct is covered almost entirely by a tunica serosa which is composed of the peritoneum making up the **mesosalpinx**.

The entire oviduct lies between the peritoneal layers of the mesosalpinx.



The oviduct of dog and serous ligaments

A small portion of the tubal part of the oviduct is in contact with the proper and suspensory ligaments of the ovary. The muscular layer of the duct (tunica muscularis) is composed primarily of circular bundles of fibers, but a variable number of longitudinal and oblique fibers are also present. The inner layer (tunica mucosa) is made up of partially ciliated simple columnar epithelium, the motion of the cilia being directed toward the uterine horn.

UTERUS

The **uterus**(or womb) is a tubular, Y-shaped organ which serves as the habitation for the developing young. It gives attachment to the fertilized ovum and functions as a source of fetal nourishment. It also serves as the route by which the sperm may reach the ovum in the oviduct.It communicates with the oviducts cranially and the vagina caudally.

The uterus consists of a **neck or cervix** (cervix uteri), a **body** (corpus uteri), and two **horns** (cornua uteri).

The uterine horns (cornua uteri) are united at the body of the uterus. The cranial tip of each horn is connected to the ovary by the proper ligament and indirectly by the broad ligament. The oviduct opens into the uterine horn at or near its tip.

The body of the uterus (corpus uteri) is usually located in both the abdominal and pelvic cavity. The body extends from the point of convergence of the uterine horns to the cervix. There are three openings into the uterine body: one from each uterine horn and one from the internal orifice of the cervix. The canal of the cervix is directed from uterus to vagina. The external uterineorifice (ostium uteri externum) is opens into the vagina.

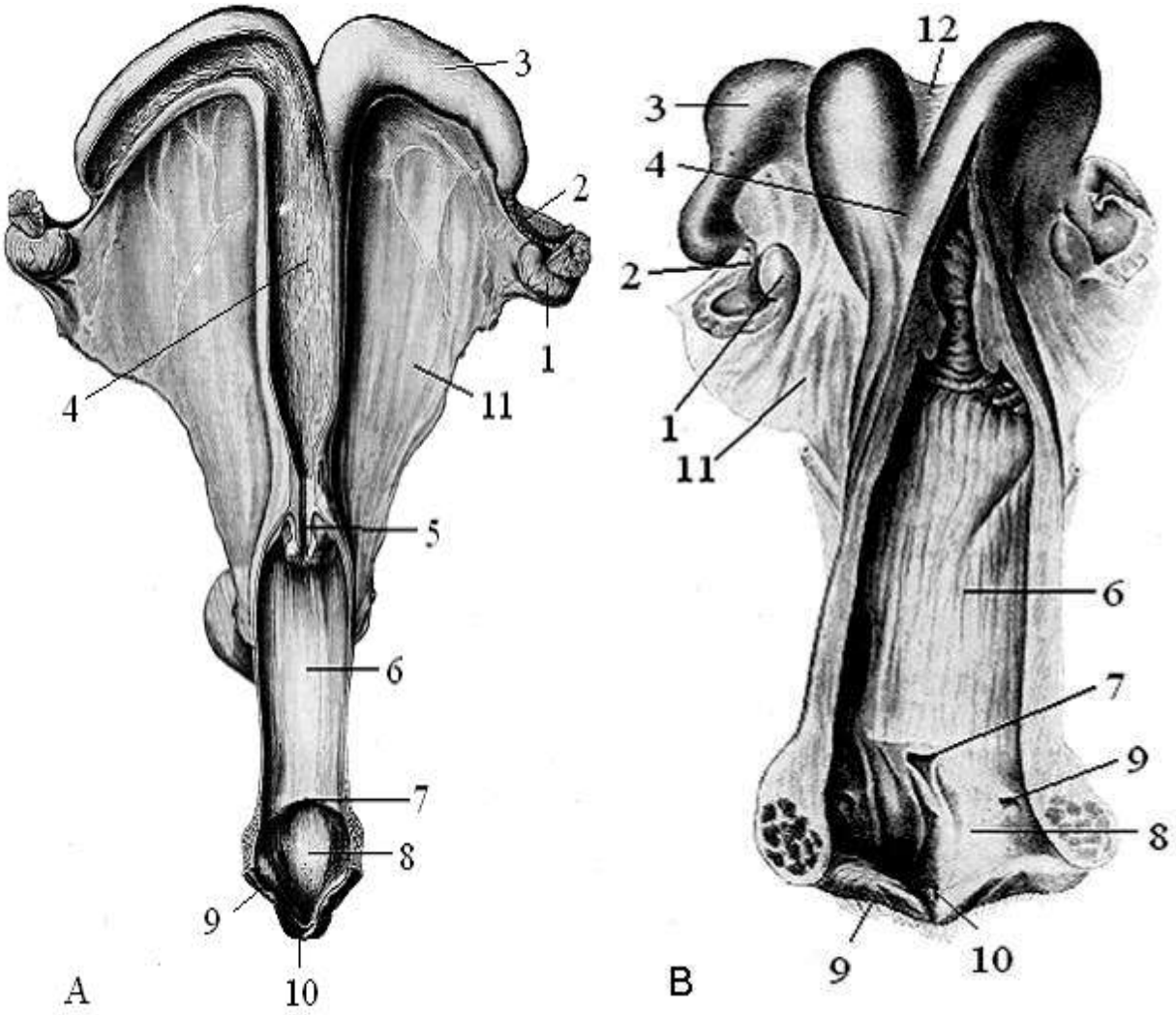
Ligaments.

The broad ligaments attach the uterus and ovaries to the body wall. The mesometrium is that part of the broad ligament which attaches the uterus to the dorsolateral body wall. The mesometrium and the lateral ligament of the bladder fuse at their attachments to the pelvic wall.The round ligament of the uterus (ligamentum teres uteri) is attached to the cranial tip of the uterine horn and is a caudal continuation of the suspensory and proper ligaments of the ovary.

Structure.

The uterus is made up of three tunics: serosa, muscularis, and mucosa. The tunica serosa **(perimetrium)** is continuous with the mesometrium of the broad ligament.

The tunica muscularis **(myometrium)** consists of a thin, longitudinal outer layer and a thick, circular inner layer of involuntary muscle. A vascular layer (stratum vasculare) lies between these two layers. The circular layer is especially thick in the region of the cervix.



Female genitalia

A – mare, B – cow

1 – ovary, 2 – oviduct, 3 – uterine horn, 4 – body of uterus, 5 – neck of uterus, 6 – vagina, 7 – external opening of the urethra, 8 – vestibule of vagina, 9 – vulva, 10 – clitoris, 11 – broad ligament, 12 – intercornual ligament.

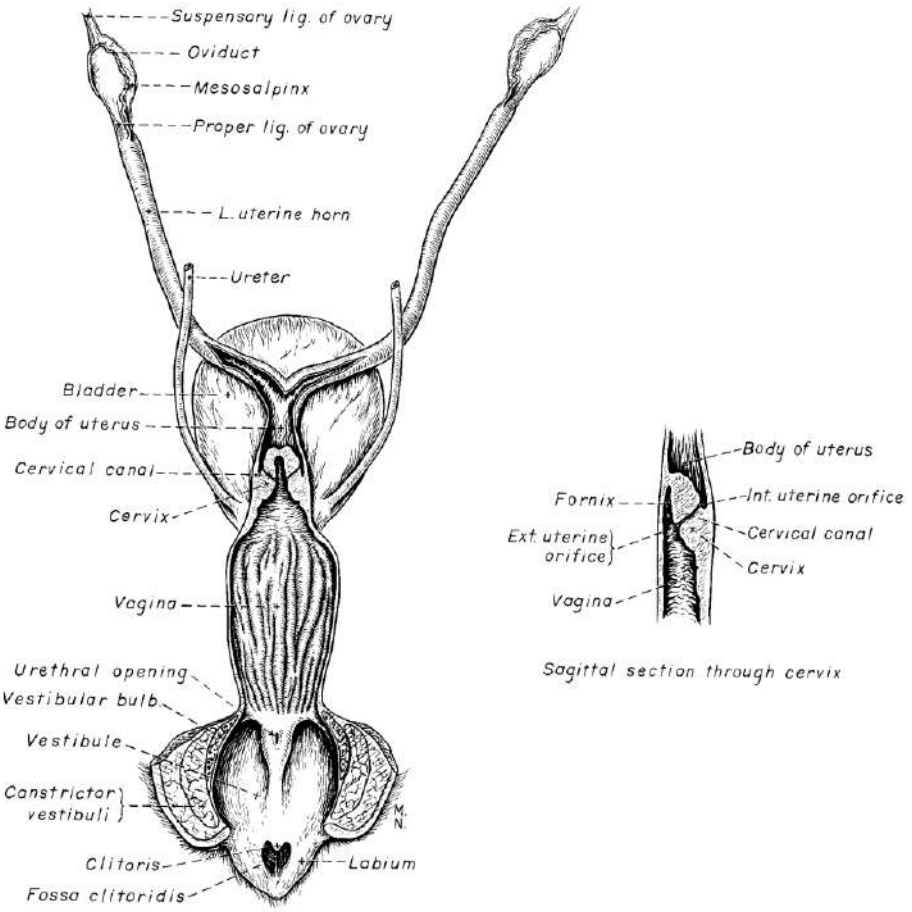
The tunica mucosa **(endometrium)** is the thickest of the three uterine tunics. The lumen of the uterus is a layer of low columnar epithelium whose cells are only temporarily ciliated. Simple branched tubular glands are present in the lamina propria.

The neck of uterus of the **mare** is the constricted posterior part which joins the vagina. Part of it is a vaginal part of cervix ***(portio vaginalis cervicis).***It projects into the cavity of the vagina; it is not visible externally, but may be felt through the vaginal wall.

The muscular coat of the uterus of the **cow** is thicker than in the mare. It consists of an external longitudinal layer and two circular strata. The inner circular layer is thick in the cervix. The mucous membrane of the horns and body presents as a characteristic feature the ***uterine caruncles*** (carunculae). These are oval prominences, about a hundred in number, which are either irregularly scattered over the surface or arranged in rows of about a dozen.

The uterine glands are long and branched. The mucous membrane of the cervix forms numerous folds. The latter 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 the vagina ***(portio vaginalis cervicis).***



Dorsal aspect of femail genitalia of dog, partially opened in mid line

VAGINA and **VESTIBULE OF VAGINA**

The **vagina** is a highly dilatable canal, extending from the uterus to the vulva. Cranially, the vagina is limited by the fornix and the intravaginal cervix. The **fornix** is the slitlike space to the intravaginal part of the cervix. The longitudinal folds (rugae) of the vaginal mucosa are high, allowing for great expansion in diameter.

The border between the vagina and the vestibule of the vagina is the external opening of the urethra (ostium urethrae externum), which opens on the ventral wall of the vagina.

The vaginal walls are made up of an inner mucosal layer, a middle smooth muscle layer, and an external coat of connective tissue and peritoneum (cranially). The tunica mucosa is non-glandular, stratified epithelium.

The **vestibule** (vestibulum vaginae) is the space connecting the vagina with the external genital opening. The space is variable in size, depending on the size of the animal and whether or not she is pregnant.

The wall of the vestibule of the vagina consists of a mucous, muscular coat and the adventitia.

Mucosa lined by stratified epithelium, has lymphoid nodules and glands:

- major vestibular (gll. vestibulares majores)
- minor vestibular (gll. vestibulares minores)

The vestibular glands, lobular in structure, open ventrally on each side of the median ridge. The glands are located deep to the constrictor vestibule muscles.

The glandula vestibulares majores in the **dog**are absent, but the minor glands are present, and their ducts open ventrally on either side of a median ridge.

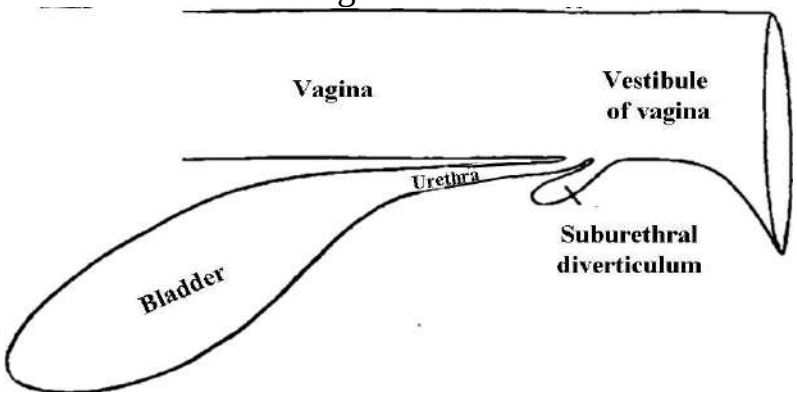
At the external urethral orifice, voluntary muscle form a strong sphincter. Under this muscle in the lateral wall is a flattened, oval body, the **bulbus vestibuli**; this is an erectile structure, homologous with the corpus spongiosum urethra of the male (composed of cavernous tissue). It consists of a venous network inclosed in a fibrous capsule.

The **vestibular bulbs** are relatively large in the bitch and mare.

FEMALE URETHRA

The **female urethra** (urethra feminina) is lined by folded mucous membrane. From the anus, the vulva separated by a perineum. The mucosa is non-glandular. The musculature of the female urethra consists of outer and inner longitudinal and middle circular layers of unstriped muscle.

In the ventral wall of the **cow's** urethra (under the external urethral orifice) is the **suburethral diverticulum**, which is approximately 3 to 4 sm long, and readily admits the end of a finger.



The suburethral diverticulum of the cow

The form and position of this pocket should be carefully noted on account of the difficulty it causes in ***catheterizing*** the bladder. If the catheter is passed along the ventral wall of the vulva (as in the mare), it will always enter the pocket instead of the urethra.

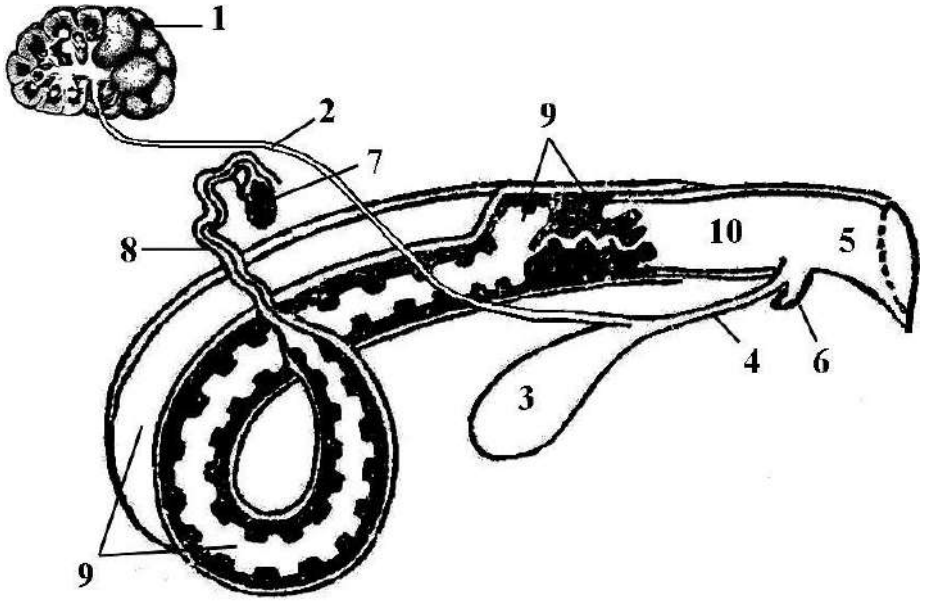
VULVA

The **vulva** (pudendum femininum), or **external genitalia** (partes genitales femininae externae), consists of clitoris and pudendal lips. The vulva and anus are separated by a **perineum**.

The **pudendal lips** (labia pudendi) form the external boundary of the vulva. The lips fuse above and below the pudendal fissure to form dorsal and ventral vulvar commissures. The labia are rich in sebaceous and tubular glands.

The clitoris, the homologue of the male penis, is composed of paired crus (crus clitoridis), a body (corpus clitoridis), and a glans (glans clitoridis). The crus and body are homologues of the male corpora cavernosa penis, and the glans clitoridis (possessing erectile tissue) is homologous with the glans penis.

The glans clitoridis, made up of erectile tissue, contains numerous sensory nerve endings.



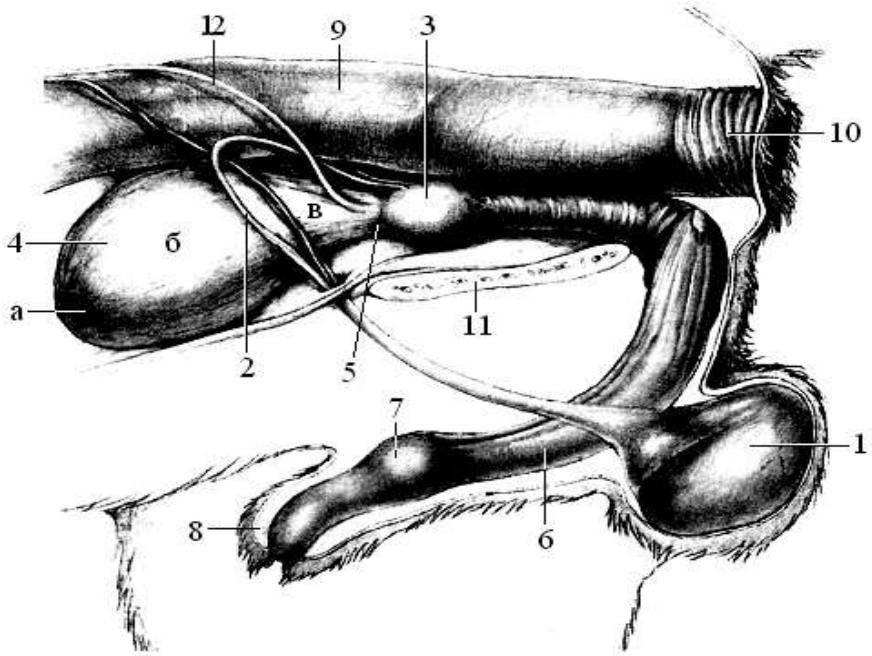
The urogenital apparatus of a cow

1 – kidney
2 – ureter
3 – bladder
4 – urethra
5 – vestibule of the vagina
6 – diverticulum of urethra
7 – ovary
8 – uterine tube
9 – uterus
10 – vagina

MALE GENITAL ORGANS
ORGANA GENITALIA MASCULINA

ANATOMICAL COMPOSITION OF THE MALE GENITAL ORGANS

1. **Testis**– *testis, s. orchis s. didymis*
2. **Epididymis** – *epididymis*
3. **Deferent duct** – *ductus deferens (vas deferens)*
4. **Spermatic cord** – *funiculus spermaticus*
5. **Urogenital canal** – *canalis urogenitalis* – male urethra
6. **Accessory genital glands** – *gll. genitales accessoriae:*
   a) **vesicular gland** or **seminal vesicle** – *gl. vesicularis*
   b) **prostate** – *prostata*
   c) **bulbourethral** – *gl. bulbourethralis*
7. **Scrotum** – *scrotum*
8. **Penis** – *penis, s. phallos*
9. **Prepuce** – *praeputium*

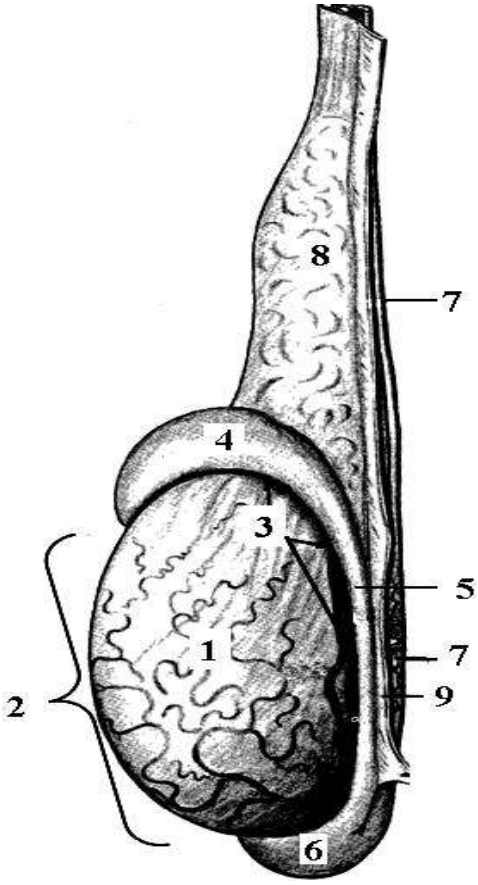


The urogenital apparatus of a dog's male

1 – testis;
2 – deferent duct;
3 – prostate;
4 – bladder (а – apex, б – body, в – neck);
5 – male urehtra;
6 – penis;
7 – bulb of penile glans;
8 – prepuce;
9 – colon;
10 – rectum;
11 – part of pelvic bone,
12 – ureter.

TESTIS

Testis (testis, s. orchis, s. didymis), or male gonads, is a pair parenchymatous organ, in which adult animals is synthesized spermatozoa and sex hormones (testosterone). Testis is a gland external and internal secretion.



Each testis has:

tips:

- capitate (extremitas capitata)
- tailed (extremitas caudata)

borders:

- free (margo liber)
- epididymal (margo epididymalis)

surfaces:

- lateral (facies lateralis)
- medial (facies medialis)

The left testis of bull
(lateral aspect)

1 – testis
2 – free edge of the testis
3 – epididymal edge of the testis
4 – head of epididymis
5 – body of epididymis
6 – tail of epididymis
7 – deferent ducts
8 – spermatic cord
9 – remains of mesentery of the testis

The testes are located within the scrotum. Each testis is oval in shape and thicker dorsoventrally than from side to side.

The body of the epididymis lies on epididymal margin of the testis. The opposite edge of the testis is free. Capitate endind has head of epididymis. Tailed ending of the testis is the opposite capitate and bears the tail of the epididymis. The deferent duct begins from the tailed ending of epididymis.

The surface of the testis is covered by the **vaginal tunic** (tunica vaginalis propria), a serous membrane continuous with the parietal peritoneum of the abdominal cavity. Deep to the proper vaginal tunic is the **tunica albuginea**, a dense, white fibrous capsule. At the epididymal attachment to the dorsomedial border of the testis, the tunica albuginea joins the **mediastinum** testis by means of connective tissue **lamellae** (septula testis), which converge centrally. The lobuli testis are bounded by the septula. The lobuli contain the ***convoluted seminiferous tubules*** (tubuli seminiferi contorti), a large collection of twisted canals. Spermatozoa are formed from the epithelial lining of the tubules, which contains spermatogenic cells. ***Straight tubules*** (tubuli recti) are formed by the union of the seminiferous tubules of a lobule. These congregate in the ***rete testis.***

The ***mediastinum of testis*** contains a network of confluent spaces and ducts called the ***rete testis***. Testicular blood vessels and lymphatics enter and leave through the mediastinum. The lobuli of testis also contain ***interstitial cells*** (of Leydig), which are thought to produce testosterone, an internal secretion.

The ***efferent ductules of testis*** (ductuli efferentes testis) are originated from rete. These are combined and sent to the head of epididymis.

The body and tail of the epididymis contain the ***duct of epididymis*** (ductus epididymidis). At the tail of epididymis the duct continues into the **deferent duct** (ductus deferens).

EPIDIDYMIS

The **epididymis** is the organs where spermatozoa are stored before initiation of ejaculation. It lies along the dorsolateral border of the testis. The **head** (caput) of the epididymis begins on the medial surface of the testis but immediately twists around the cranial extremity to attain the lateral side. It is slightly larger than the remainder of the epididymis.

It continues as the **body** (corpus), which runs along the dorsolateral surface of the testis, and then as the **tail** (cauda epididymidis), which is attached to the caudal extremity of the testis by the ligament of the epididymis. It is continued craniodorsally up the spermatic cord as the **ductus deferens.** Its medial edge is attached to the testis by the proper vaginal tunic.

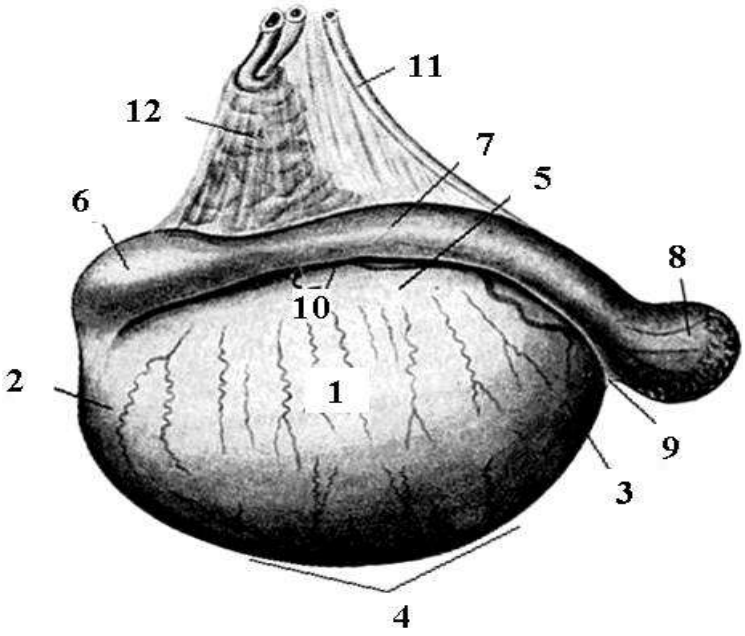
The dips in between the lateral edge of the epididymis and the testis, under the body of the epididymis, form a potential space, the **sinus epididymis**. The sinus is limited cranially and caudally by the epididymal head and tail, which adhere tightly to the testis.

In addition to being a storage place for spermatozoa, the epididymis slowly transports spermatozoa to the ductus deferens.

Species features of the testis

The testis of stallion

1. The testis is compressed laterally and has a horizontal position.
2. The capitate end is directed cranially, caudate – caudally; epididymal margin – dorsally.
3. The sinus of the epididymis is good defined.
4. The epididymis does not go to the ends of the testis.
5. Length is 12 cm.

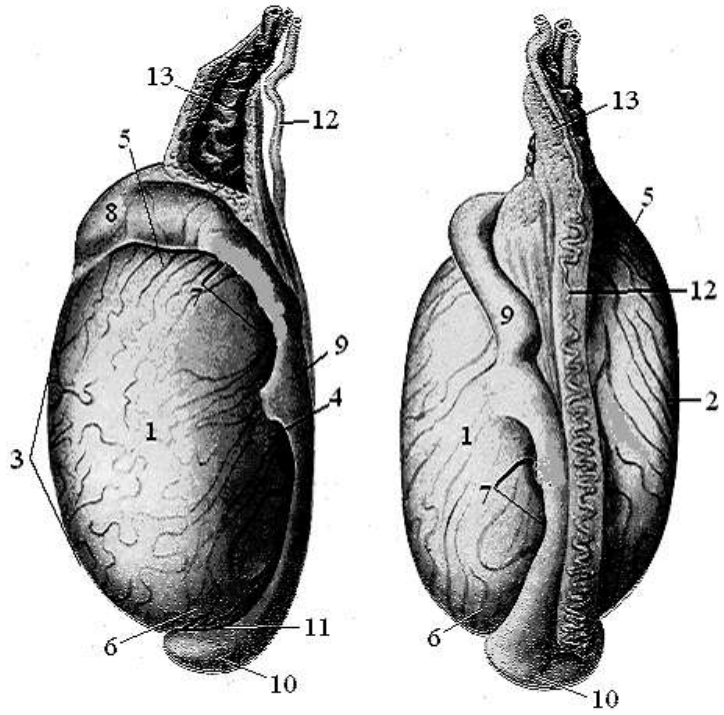


The testis, epididymis, deferent duct and spermatic cord of stallion

1 – testis (lateral surface)
2 – capitate ends
3 – tailed end
4 – free border
5 – epididymal border
6 – head of the epididymis
7 – body of the epididymis
8 – tail of the epididymis
9 – proper ligament of testis
10 – sinus epididymis
11 – deferent duct
12 – spermatic cord

The testis of the bull are relatively larger than those of the horse, and have an elongated, oval outline. The long axis is vertical.

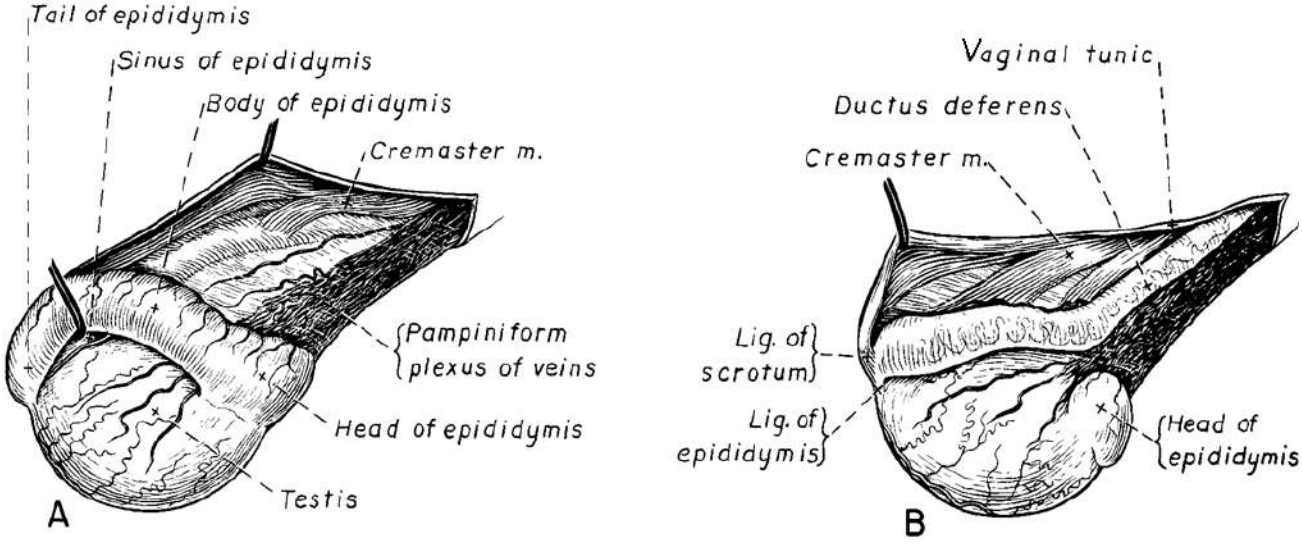
The capitate end is directed dorsally, caudate end – ventrally; epididymal margin – caudally. The body of the epididymis of the testis narrows.



The testis, epididymis, deferent duct and spermatic cord of the bull

1 – lateral surface
2 – medial surface
3 – free border
4 – epididymal border
5 – capitate end
6 – tailed end
7 – sinus epididymis
8 – head of the epididymis
9 – body of the epididymis
10 – tail of the epididymis
11 – proper ligament of testis
12 – deferent duct
13 – spermatic cord

The testis of the dog is relatively small, and has a round-oval form. In normal position, is situated obliquely, with the long axis running dorsocaudally. The epididymis is adherent to the dorsolateral surface of the organ, with its tail located at the caudal extremity of the testis, and its head at the cranial end.



The testis, epididymis, deferent duct and spermatic cord of the dog.
A – right testis (lateral aspect)
B – left testis (medial aspect)

DEFERENT DUCT

The **deferent duct** *(ductus deferens)* is the continuation of the duct of epididymis. Beginning at the tail of the epididymis, it runs along the dorsomedial border of the testis, ascends in the spermatic cord, and enters the abdominal cavity through the inguinal canal. Running in the deferential fold of peritoneum, it crosses ventral to the ureter at the lateral ligament of the bladder and penetrates the prostate to open into the urethra, lateral to the colliculus seminalis.

The muscular layers of the ductus deferens are poorly defined. Three layers of smooth muscle are generally recognized: an outer and an inner longitudinal, and a middle circular. The mucosa is made up of simple or pseudostratified columnar epithelium.

A distinct **ampulla** of the deferent duct is not obvious in the dog as it is in ruminants. In the horse, there is no increase in the lumen of the tube, but rather a thickening of the wall.

SPERMATIC CORD

Each **spermatic cord** (funiculus spermaticus) is complex of the organs which located in the inguinal canal. These structures migrate into the scrotum during the descent of the testis. The spermatic cord covers by vaginal tunic.

The **spermatic cord** includes follow structures:

- ***deferent duct***
- ***a. spermatica interna***
- ***v. spermatica interna (plexus pampiniformis)***
- ***plexus neuralis spermatica interna***
- ***vasa lymphatica***

The components of the spermatic cord (vaginal process) are joined together by loose connective tissue and peritoneum, which is designated as the vaginal tunic. The ductus deferens, with its vessels, is enveloped by one fold of peritoneum, and the testicular vessels and nerves are covered by another. The double layer of peritoneum uniting these two folds to each other is continuated to **mesorchium**.

The spermatic cord passes through the inguinal canal in its course through the abdominal wall.

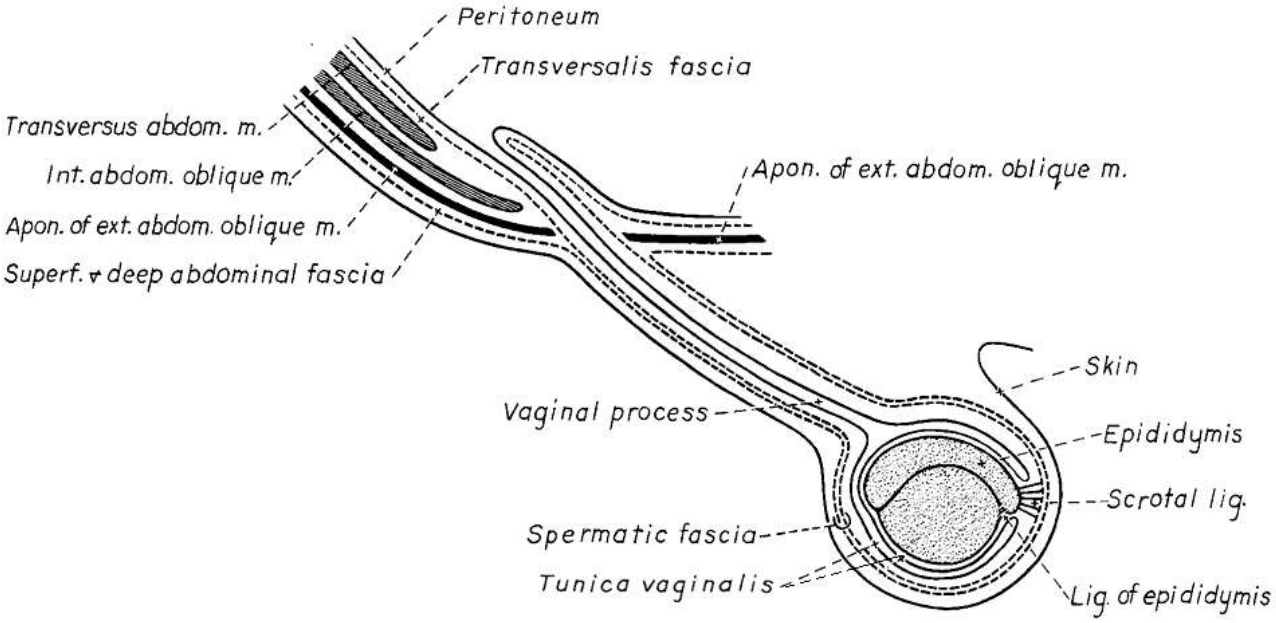


Diagram of sagittal section of inguinal canal and vaginal process of the dog

As the spermatic cord and testis pass through the inguinal canal, transversalis fascia (underlying parietal peritoneum) is reflected onto the tunica vaginalis, and is here known as **internal spermatic fascia**.

The **cremaster muscle**, a caudal fasciculus of the internal abdominal oblique muscle, passes down between the internal and the external spermatic fascia.

UROGENITAL CANAL (MALE URETHRA)

The **urogenital canal** (urethra masculina) carries both urine and seminal secretions to the distal end of the glans penis. It passes backward on the floor of the pelvis, turns around the ischial arch, forming an acute angle, and passes forward inclosed in the corpus spongiosum.

It is divisible into two parts: the ***pelvic*** and ***penile*** or ***cavernous.*** The ***pelvic*** part (pars pelvina) passes through the pelwic cavity. It extends from the urethra to the caudal edge of the ischial bones, where the ***penile*** part begins. Behind the prostate the tube dilates. Near the ischial arch, between the bulbo-urethral glands, it contracts again, forming the **isthmus urethrae.**

It is inclosed, except at its origin, by the urethral muscle. Beneath this is a rich venous plexus, forming a sort of erectile tissue.

The **seminal hillock** (colliculus seminalis) is an oval enlargement, located at the center of the urethral crest, which protrudes into the lumen of the urethra. Also, numerous ducts of the accessory glands open into the pelvinal portion adjacent to and surrounding the urethral crest.

The ***cavernous***, or ***penile***, portion (pars cavernosa) of the urethra extends to the external opening in the distal end of the pars longa glandis. It passes between the two crura of the penis and runs along the groove on the ventral surface of the corpus cavernosum penis, inclosed by the corpus spongiosum and the bulbo-cavernosus muscle.

This part is covered by a delicate integument, under which there is a thin layer of erectile tissue. It projects forward in the fossa glandis as a free tube the **processus urethrae.**

Dog has not fossa navicularis, such as is present in the bull.

ACCESSORY GENITAL GLANDS

The **vesicular**, the **prostate**, and the **bulbourethral glands** discharge their secretions into the urethra, where they mix with the seminal fluid secreted by the testicles; hence they are often terme.

ACCESSORY GENITAL GLANDS OF STALLION

The **vesicular** are two elongated and somewhat pyriform sacs, which lie on either side of the posterior part of the dorsal surface of the bladder. Each consists of a rounded blind end, the **fundus,** a middle, slightly narrower part, the **body,** and a posterior constricted part, the **neck** or **duct.** In the stallion they are long, and their greatest diameter is about 2-5 cm.

The **prostate** (prostata) is amusculo-glandular organ which lies on the neck of the bladder and the beginning of the urethra. It consists of two ***lateral lobes*** and a connecting ***isthmus***. The **lateral lobes,** right and left (lobus dexter et sinister), are somewhat prismatic in form. The **isthmus** is a thin, transverse band. It lies over the junction of the bladder with the urethra.

The **bulbourethral glands** (glandulae bulbourethrales) are two in number, and are situated on either side of the pelvic part of the urethra close to the ischial arch. They are covered by the urethral muscle. They are ovoid in form.

ACCESSORY GENITAL GLANDS OF BULL

The **vesiculae seminales** are not bladder-like sacs, as in the horse, but are compact glandular organs with a lobulated surface.

The **prostate** is pale yellow in color, and consists of two parts. The **body** is a mass which stretches across the dorsal surface of the neck of the bladder aud the origin of the urethra. The **pars disseminata** surrounds the pelvic part of the urethra. The **prostatic ducts** open into the urethra in rows between two folds of the mucous **membrane** which proceed backward from the colliculus seminalis

The **bulbourethral glands** are somewhat smaller than in the stallion. Each has a single duct which opens into the urethra under cover of a fold of the mucous membrane.

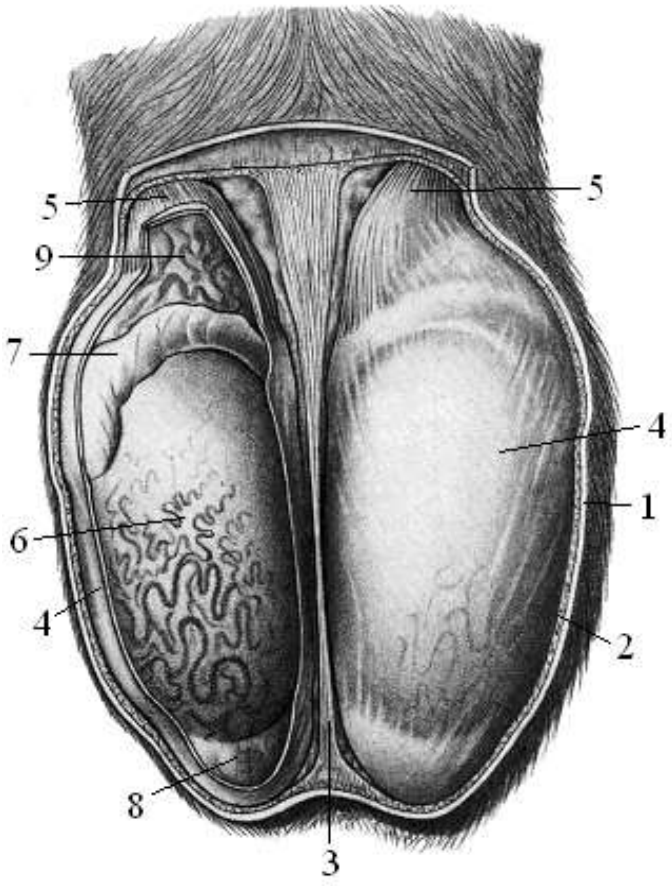
ACCESSORY GENITAL GLANDS OF DOG

The **vesicula seminales** are absent.

The **prostate gland** (prostata) is a musculoglandular body that completely encompasses the proximal portion of the male urethra and the neck of the bladder. The two deferent ducts enter the craniodorsal surface of the prostate. They run caudoventrally through the dorsal part of the gland to open into the urethra by two slits, one on each side of the colliculus seminalis. The gland is subject to much variation in size, and is often enlarged, especially in old subjects.

The **bulbourethral glands** are absent.

SCROTUM



The **scrotum** is a membranous pouch divided by a median septum into two cavities, each of which is occupied by a testis, an epididymis, and the distal part of the spermatic cord.

The scrotum with the testes of bull

(front aspect)
Scrotum is absent on the right side

The testis is presented into the vaginal tunic on the left side

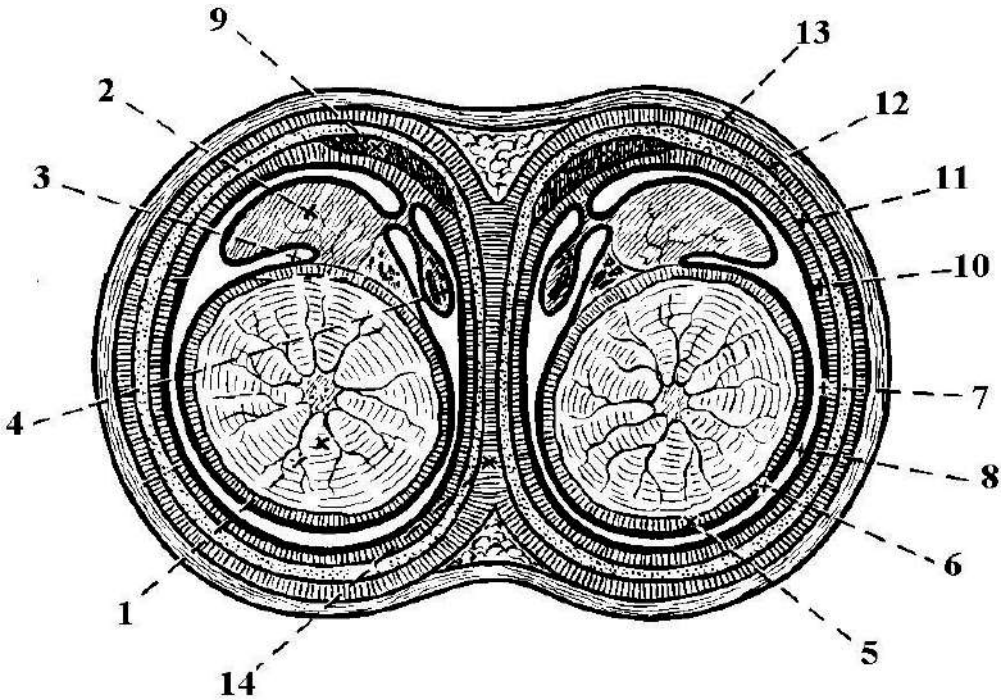
1 – skin of scrotum
2 – dartos
3 – septum of scrotum
4 – vaginal tunic
5 – cremaster of testis
6 – testis
7 – head of epididymis
8 – tail of epididymis
9 – spermatic cord

The scrotal **integument** is pigmented and covered with fine scattered hairs. Sebaceous and tubular (sudoriparous) glands are well developed.

Deep to the outer integument of the scrotum is the **dartos**, a poorly developed layer of smooth muscle mixed with collagenous and elastic fibers. The *dartos* forms a common covering for both halves of the scrotum and also helps to form the scrotal septum. The **cremaster** muscles pull the scrotum and its contents close to the abdominal wall. Contraction of the dartos muscle causes the integumentary layer of the scrotum to invest the testes more intimately, and thus helps to bring them closer to the body.

The ***vaginal tunic*** (tunica vaginalis) is differentiated from peritoneum at the point where the latter dips into the inguinal canal. It has **two layers**: **parietal** and **visceral** (laminae parietalis et visceralis). The cavity of the vaginal process is continuous with the peritoneal cavity. The **parietal layer** of the vaginal tunic is deep to the fibrous layer. This is an extension of the parietal peritoneum into the scrotum. The tunic is an epithelial membrane which secretes serous fluid into the cavity separating it from the **visceral layer** (serous tunic covering the testis). This potential space, the **vaginal cavity** (cavum vaginale), is merely the capillary space between the two serous membranes, filled only with enough fluid to allow free movement of the testes within the scrotum.

The testis is secured to the scrotal wall by the ***vaginal tunic.*** In addition, the ***scrotal ligament***, from the caudal extremity of the testis, connects the testis and epididymis to the spermatic fascia. Indirecdy, the testis is stabilized by the spermatic cord and its reflected vaginal tunics. The spermatic cord and scrotum are the principal supports of the testis.



Transverse section of the scrotum and organs which are located there

1 – testis, 2 – epididymis, 3 – sinus of epididymis, 4 – deferent duct, 5 – tunica albuginea of testis, 6 – visceral vaginal tunic, 7 – parietal vaginal tunic,8 – vaginal cavity, 9 – cremaster of testis, 10 – internal seminal fascia, 11 – external seminal fascia, 12 – dartos, 13 – skin, 14 – septum of scrotum.

PENIS

The **penis** (penis, s. phallos, s. ud) is the organ of copulation. It is composed essentially of erectile tissue, and incloses the penile part of the urethra. It extends from the ischial arch forward between the thighs on to the umbilical region of the abdominal wall. It is cylindrical in form.

It may be divided into:

- root (radix penis)
- body (corpus penis)
- glans (glans penis)

The **root** (radix penis) is attached to the lateral parts of the ischial arch by two **crura**. The urogenital canal passes over the ischial arch between the crura, and curves forward to become incorporated with the penis.

The **body** (corpus penis) begins at the junction of the crura and constitutes the bulk of the organ.

The opening from the bladder into the urethra is termed the **internal urethral orifice** (ostium urethra internum); it is closed except during urination. The terminal opening is the **external urethral orifice** (ostiumurethra externum) or meatus urinarius. The two orifices of the **deferent ducts** are situated dorsally on either side of the colliculus seminalis behind the internal urethral orifice.

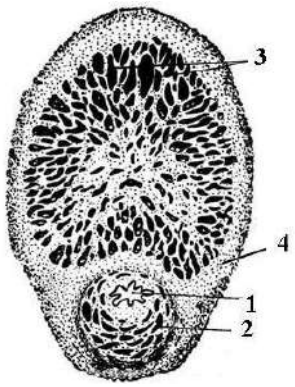
The penis is formed by cavernous bodies (corpus cavernosum penis) – right and left. Dense connective tissue of the corpus cavernosum penis forms the ***tunica albuginea***, ***trabeculae*** and the ***longitudinal septum*** of the penis (septum penis). The corpus cavernosum contains numerous sinuses, separated by connective tissue trabeculae, in which pass the blood vessels and nerves. Smooth muscle, fibrous connective tissue, and adipose tissue are found in the intersinusoidal lamellae of the corpus cavernosum penis. The glans penis is covered by stratified squamous epithelium.

The muscles of the penis:

- m. ishiocavernosus (it is fixed to ischial arch and covers the crus of the penis)
- m. retractor penis
- m. bulbocavernous

The penis of **stallion** is large. In front of glans penis is a prominent circular ridge, the **corona glandis,** which is notched below. The base of the glans is rounded and extends further backward dorsally than ventrally; it is marked in its lower part by a deep depression, the fossa glandis**.** The urethra is thus surrounded by a circular fossa, which opens superiorly into the **urethral sinus**.

The penis of the **bull** is cylindrical, and is longer and of very much smaller diameter than in the horse. Just behind the scrotum it forms an S-shaped curve, the sigmoid flexure. The glands of penis has **urethral process**.



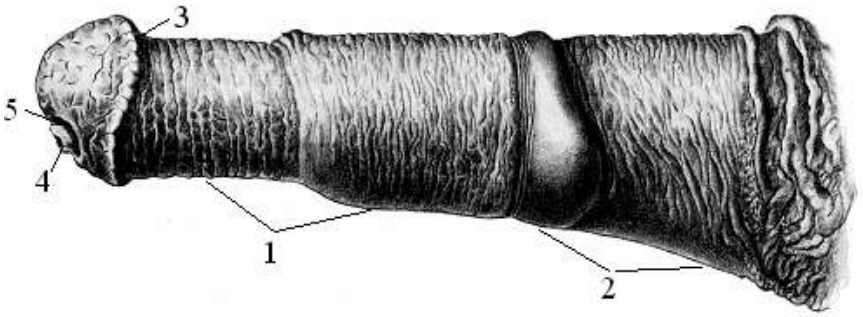
A transverse section of the penis of a bull

1 – urogenital canal
2 – cavernous layer of the urogenital canal
3 – cavernous body of the penis
4 – tunica albuginea

The penis of **dog** presents several special features. In its posterior part there are two distinct corpora cavernosa, separated by a median septum penis. In its anterior part there is a bone, the **os penis,** which in large dogs reaches a length of 10 cm or more. It is regarded as a continuation forward of the corpus cavernosum. The **glans penis** is very long, posteriorly itforms a rounded enlargement, the **bulbus glandis**. The bulbus glandis morphologically resembles and is continuous with the corpus cavernosum urethrae.

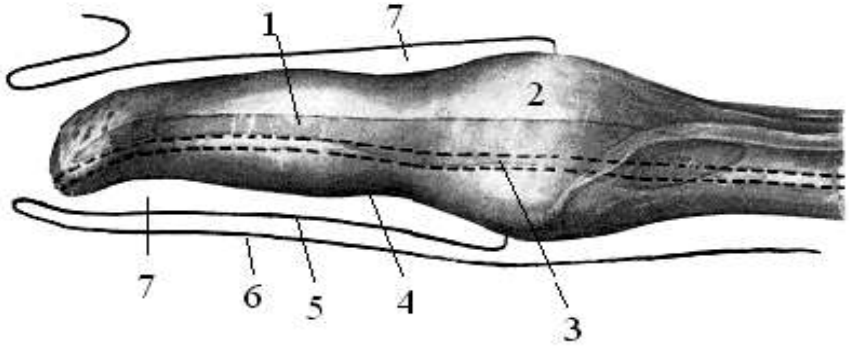
PREPUCE

The **prepuce**, or **foreskin** (praeputium) is a complete tubular sheath of integument which, when the penis is not erect, contains and covers the pars longa glandis and part of the bulbus glandis. It is firmly attached to and continuous with the skin of the ventral abdominal wall.



The glans of penis and prepuce of stallion

1 – inner prepuce
2 – outer prepuce
3 – glans
4 – orifice of urogenital canal
5 – fossa of the glans penis



The glans of penis and prepuce of dog's male

1 – glans of penis
2 – bulb of penis
3 – urogenital canal
4 – internal lamina of prepuce
5 – external lamina of prepuce
6 – skin prepuce
7 – preputial cavity

The prepuce is composed of three layers. The outer layer is ***skin***. The inner layers are presented by two **lamines:** *external* and *internal*. The external, or parietal

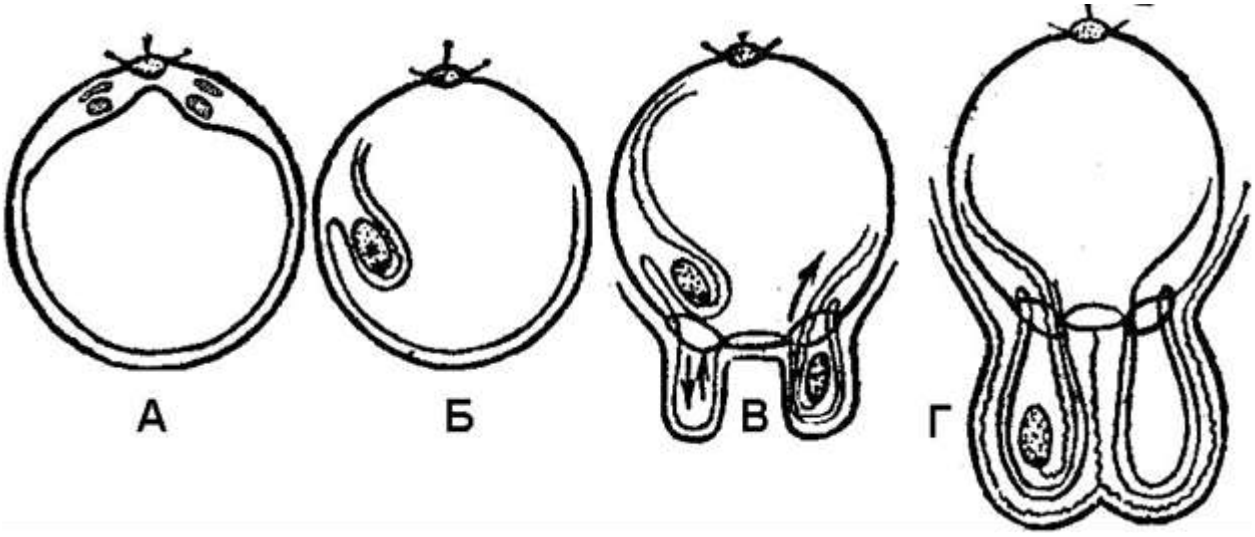
lamina is a continuation of the outer skin layer onto the wall of the **preputial cavity**. In erection, the parietal layer is reflected from the preputial orifice directly onto the body of the penis. The internal, or visceral lamina extends to the external urethral orifice.

The prepuce **of stallion** is doubling (external and internal). Each has two layers and two preputial orifices.

The preputial muscle (protractor praeputii) is a divergent strip of cutaneus trunci muscle. Two functions are attributed to the preputial muscles to prevent the cranial free end of the prepuce from hanging loosely in non-erection, and to pull the prepuce back over the glans penis after erection. During erection, the preputial muscles are relaxed.

DESCENT OF THE TESTES

During early foetal life the testicle is situated against the dorsal wall of the abdominal cavity, in contact with the ventral surface of the corresponding kidney. As growth proceeds it gradually migrates from this primitive position, and finally passes down the inguinal canal into the scrotum. Previous to its descent through the abdominal wall the testicle is suspended by a fold of peritoneum, termed the mesorchium. This fold contains the vessels and nerves of the testicle in its anterior bonier. These cords are short and connect the tail of the epididymis with the testicle; later it becomes shorter, and is termed the ligament of the epididymis. The other cord, the gubernaculum testis, extends from the tail of the epididymis to the mesorchium. After the middle of foetal life, a pouch or diverticulum of the peritoneum, the processus vaginalis, grows downward through the inguinal canal, carrying with it cremaster fibers derived from the internal oblique muscle and a layer from the transversalis fascia. It is accompanied by an inguinal extension of the gubernaculum testis. The latter blends below with the subcutaneous tissue which later becomes the dartos. The tail of the epididymis first enters the processus vaginalis, followed by the testicle with its mesorchium, which descends within this diverticulum of the peritoneum until it reaches the scrotum.



The sequence of the descent of testes of domestic animals in embryogenesis

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VISCERA

of domestic animals