

Veterinary Bioscience 1: Digestive system

Lecture 5 – From mouth to Stomach

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Key words

Salivary glands; pharynx; deglutition; oesophagus; oesophageal obstruction; comparative anatomy

Intended Learning Outcomes

At the end of this lecture you should be able to:

- Apply an understanding of the gross structure, microscopic structure and function of the salivary glands, in order to integrate the structural features of the glands with their function.
- Apply an understanding of the structure of the pharynx and the swallowing mechanism, in order to understand the key elements of the process and the most appropriate route for passing a tube into the stomach.
- Utilise your knowledge of the anatomy of the oesophagus and its relationship with other organs and structures in order to determine the likely sites of obstructions when they occur, and the implications of injury.

SALIVARY GLANDS

- secrete saliva to - moisten food (assists mastication)
- lubricate bolus during deglutition
- scattered salivary glands in lips, cheeks, soft palate and tongue
- secretions mostly mucous (carbohydrate-rich)
- majority of saliva from distinct large salivary glands:
- secretions mostly serous (watery and protein-rich)

Parotid gland:

- located superficially, ventral to ear
- larger in herbivores than in carnivores • duct travels:
- across lateral surface of *masseter* muscle in dog ⇒ opening in vestibule adjacent to upper fourth premolar tooth
- medial to ventral border of mandible in horse and ox ⇒ crosses ventral border of mandible laterally ⇒ enters vestibule as for dog

Mandibular gland:

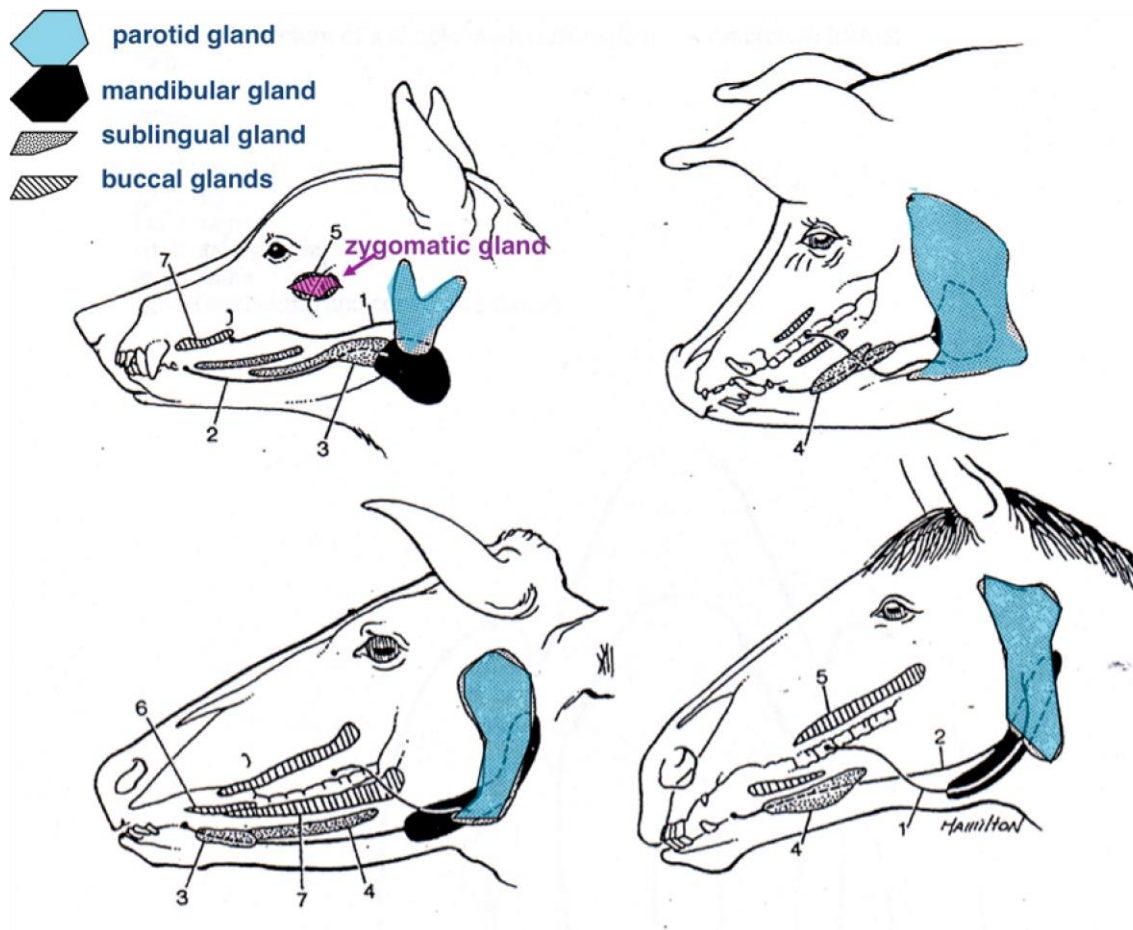
- located at angle of jaw
- deeper and larger in herbivores
- duct opens at sublingual caruncle (close to frenulum)

Sublingual gland:

- monostomatic (single duct) and polystomatic (multiple ducts) parts in most species
- ducts run along floor of oral cavity and open adjacent to frenulum

Zygomatic gland:

- present in dog and cat
- medial to zygomatic arch (in orbit)
- duct opens opposite last upper molar



Distribution of salivary glands (Dyce et al, 1987, Fig. 3-13, p. 103)

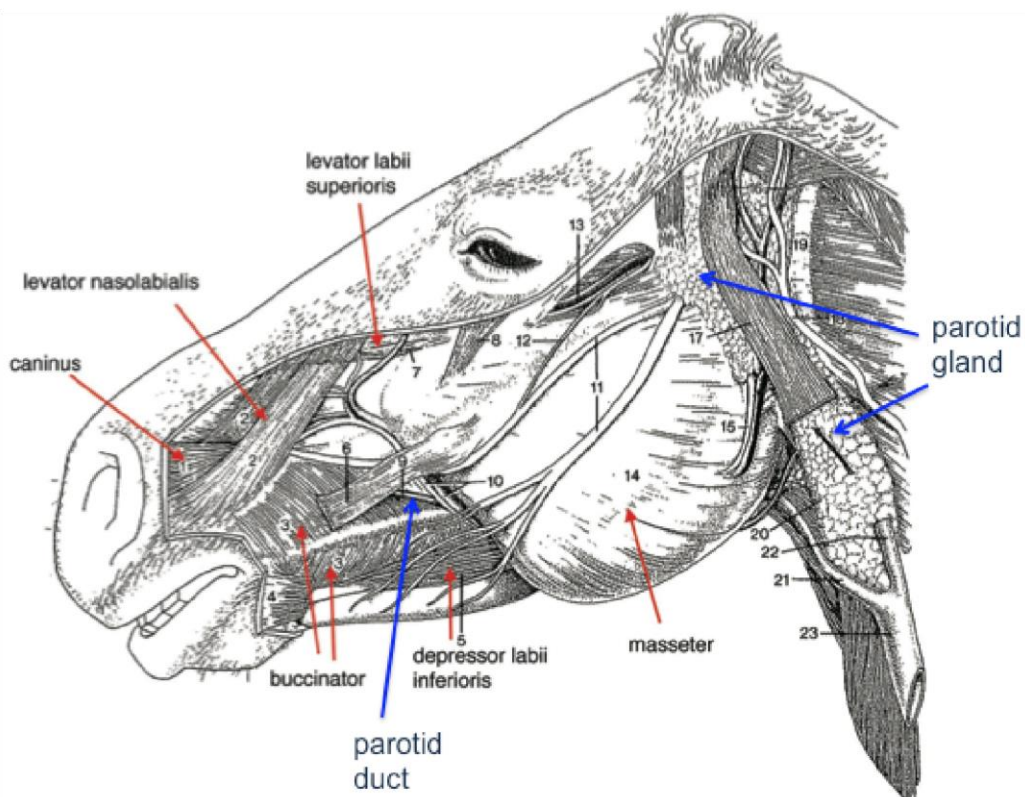


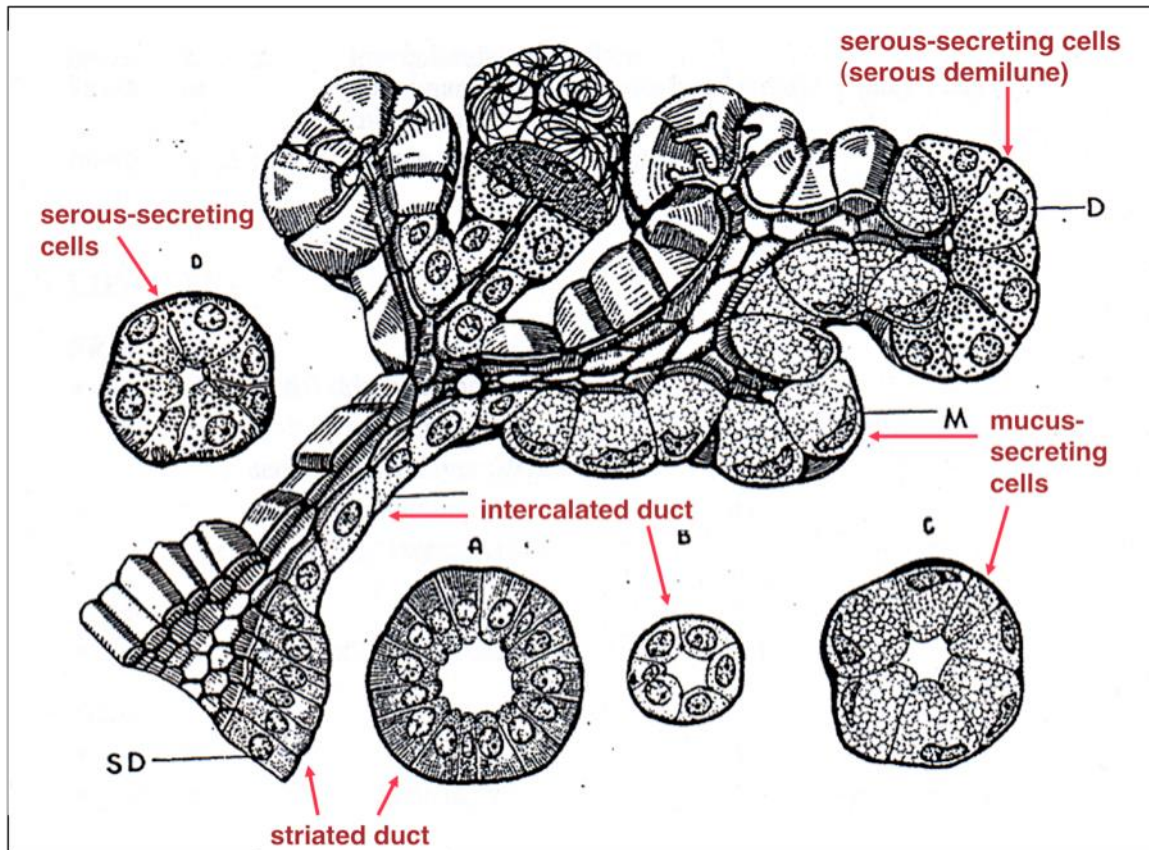
FIGURE 18-6. Superficial dissection of the head of the horse. (Dyce et al, 1987, p. 466)

Microscopic structure of salivary glands:

- branching duct system:

acinus \Rightarrow intercalated duct \Rightarrow striated duct \Rightarrow interlobular duct \Rightarrow primary duct

- secretory cells arranged in acini (clusters of cells arranged around a lumen) surrounded by basement membrane
- contain serous or mucous acini, or both



Structure of a mixed salivary gland (Jamieson, 1983, Fig. 21-16, p. 766)

Acini

Serous

- cells pyramidal
- round basal nuclei
- basophilic perinuclear cytoplasm
- secretory granules in apical cytoplasm

Mucous

- cells swollen with mucous secretions
- flattened basal nucleus

Mixed glands

- individual acini composed entirely of serous or mucous cells, or both:
- *serous* demilunes in mixed acini

Parotid gland: purely serous in most species (not dog)

Mandibular and sublingual glands: mixed mucous and serous

Ducts

<i>Intercalated duct:</i>	low cuboidal epithelium
<i>Striated duct:</i>	columnar epithelium with basal striations (alignment of mitochondria)
<i>Interlobular duct:</i>	simple columnar \Rightarrow stratified columnar

Innervation:

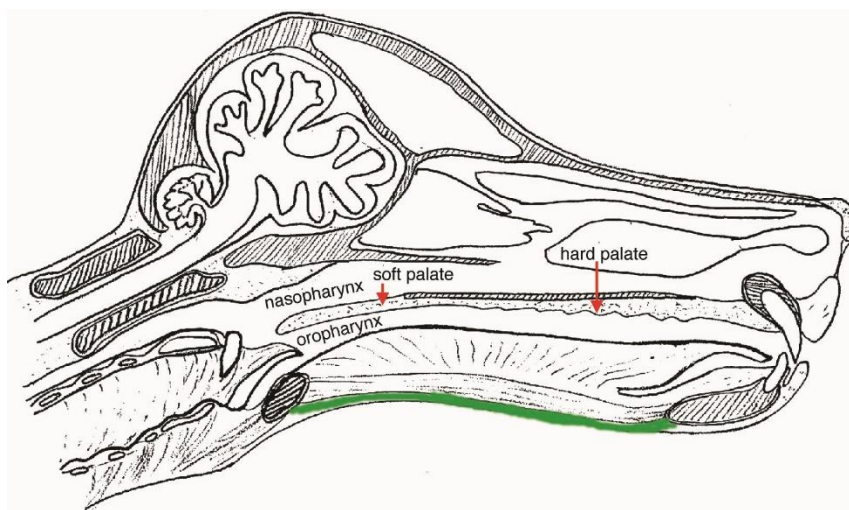
- secretion under autonomic (parasympathetic) control:
- cranial nerve VII (facial) \Rightarrow mandibular, sublingual, buccal and zygomatic glands
- cranial nerve IX (glossopharyngeal) \Rightarrow parotid gland

PHARYNX

- region common to digestive and respiratory tracts
- demarcated from oral cavity by *palatoglossal arch*
- lined by mucosa with mucous glands, and collagen and elastic fibres in lamina propria
- wall formed by three groups of muscles:
 - constrictors
 - dilator
 - shortener
- lymphoid tissue (defence against infection) - both scattered and in *tonsils*
 - tonsils may have smooth surface (e.g. palatine tonsil, dog) or crypts (e.g. palatine tonsil, horse)
- partially subdivided by soft palate into *nasopharynx* (dorsal to soft palate) and *oropharynx* (ventral to soft palate)
- HORSE: epiglottis overlaps with an elongated soft palate, holding it in the nasopharynx (except during swallowing. Therefore horses are obligate nasal breathers, and a stomach tube must be placed via the nose.

Innervation:

Motor and sensory: - contributions from cranial nerves IX and X (vagus).



Sagittal section of dog's head

DEGLUTITION

- initiated voluntarily, but taken over by reflexes once food reaches pharynx

Bolus of food prepared by mastication and insalivation



apex of tongue pressed against palate



rapid contraction of mylohyoideus and extrinsic muscles of tongue to propel food into pharynx



contact with pharyngeal mucosa sets off reflexes



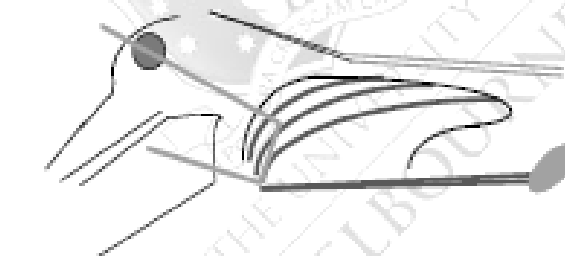
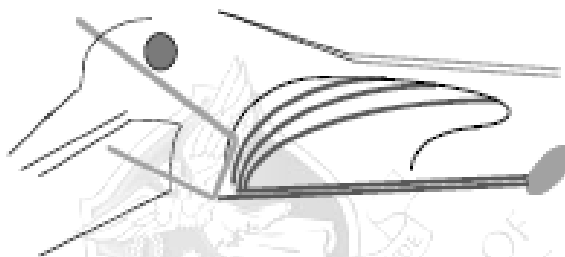
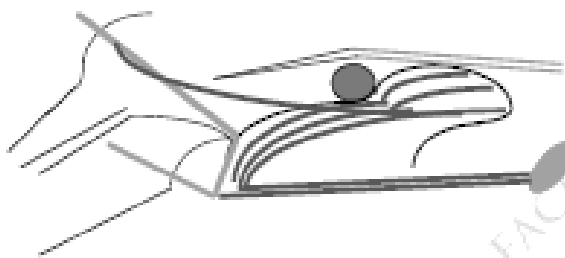
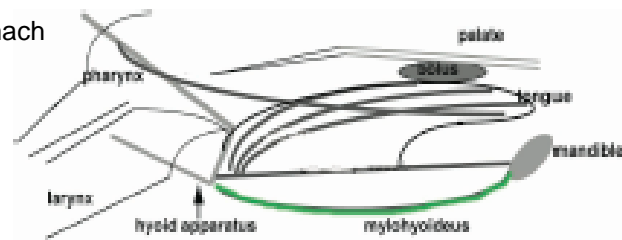
soft palate raised, glottis (narrowest part of larynx) closed, hyoid apparatus drawn rostrally, pharynx shortened (by pharyngeal shorteners)



bolus moved into oesophagus by pharyngeal constrictors



wave of peristalsis conveys bolus to stomach



De-glutition

OESOPHAGUS

- also known as the gullet

Function

- to conduct food from the mouth to the stomach

Structure

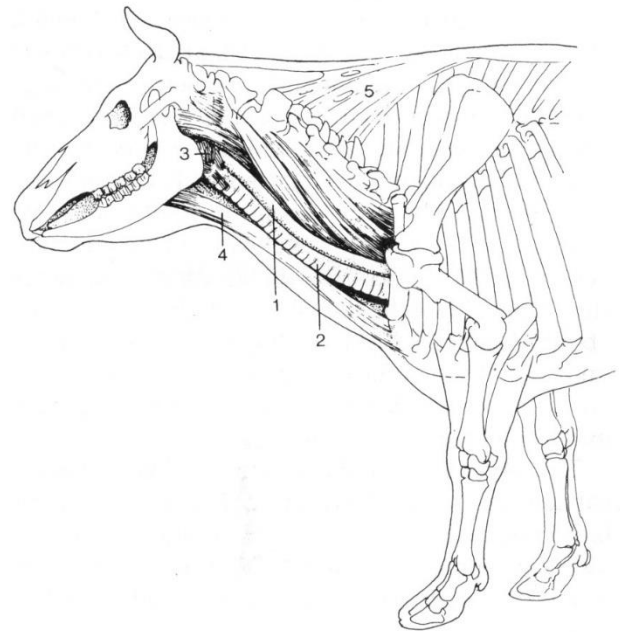
- simple muscular tube that runs from the pharynx to the stomach in 3 segments:
- *cervical, thoracic and abdominal*

Cervical segment:

- from pharynx to thoracic inlet (surrounded by 1st ribs, 1st sternebra and 1st thoracic vertebra)
- begins dorsal to cricoid cartilage of larynx (immediately rostral to beginning of trachea)
- follows trachea down neck, initially inclining to left ○ medial to left jugular groove ○ returns to median position above trachea at about level of 1st rib

Figure 3-29. Lateral view of the bovine neck. In midneck the esophagus lies on the left dorsolateral aspect of the trachea.

1, Esophagus; 2, trachea; 3, pharyngeal musculature; 4, sternocephalicus muscle; 5, nuchal ligament.



Thoracic segment:

- runs within mediastinum in thorax (mediastinum formed from membranes that separate thorax into two pleural cavities and surround unpaired structures such as heart and oesophagus)
- passes over base of heart
- crosses right side of aortic arch (beginning of aorta as it leaves heart)
- runs dorsal to bifurcation of trachea (branching of trachea into two bronchi)
- diverges slightly to left as it runs caudally in mediastinum ventral to aorta
- penetrates oesophageal hiatus of diaphragm (muscular structure separating thorax from abdomen)

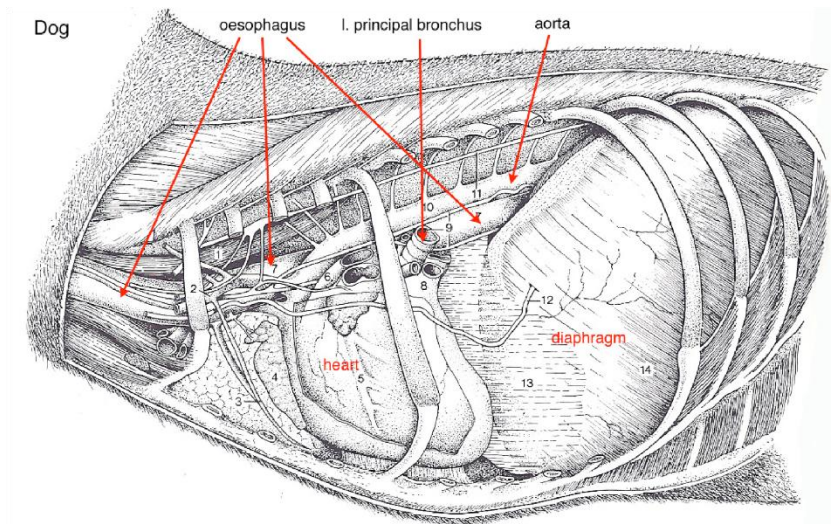


FIGURE 13-9. Left lateral view of the thoracic cavity; the lung and much of the pericardium have been removed. Dvce et al. 1987. p. 404.

Abdominal segment:

- very short, especially in ruminant
- passes over dorsal border of liver (indenting it) to join the stomach dorsally at the cardia

Structure of wall of oesophagus

- conforms to common pattern of alimentary canal, with four main layers:

- Mucosa*
- Submucosa*
- Muscularis externa*
- Adventitia or Serosa*

Mucosa:

- innermost layer, facing lumen
- thrown into prominent longitudinal folds, thus great dilation of tube possible
- composed of 2-3 layers-

Epithelium -stratified squamous keratinised or non-keratinised, depending on species (depends on consistency of ingested food - usually keratinised in horse, ruminant and pig but not in carnivore)

Lamina propria - rich in collagen and elastic fibres; leucocytes; ducts of submucosal glands

Muscularis mucosae -thin layer of smooth muscle in mucosa at caudal end of oesophagus

- usually absent at cranial end (subject to species variation)
- provides localised movement of mucosa

Submucosa:

- Loose connective tissue, mainly collagen and some elastic fibres o rich in glands - produce mucus for lubrication
- contains glands at cranial end in most species (but along full length of oesophagus in dog)

Muscularis externa:

- muscle layer which moves food into stomach by contraction
- cranial and caudal oesophageal sphincters* suggested based on functional studies rather than morphological evidence; capable of maintaining intra-oesophageal intraluminal pressure higher than intra-gastric pressure. (The caudal "sphincter" in the horse has sufficient tone that it usually remains closed during gastric dilation to the point of gastric rupture without vomiting occurring.)
- Usually thickest layer of wall
- Two layers of muscle - difficult to define at cranial end, but at caudal end obvious inner circular and outer longitudinal layers
- dog and ruminant- composed of skeletal muscle throughout; other species- usually skeletal at cranial end - becomes smooth at caudal third

Adventitia/serosa:

- outermost layer
- Adventitia* - where connective tissue merges with that of surrounding structures, e.g. in the neck, within the mediastinum.
- Serosa* - where oesophagus lies within the abdomen (very short); connective tissues covered by epithelial layer

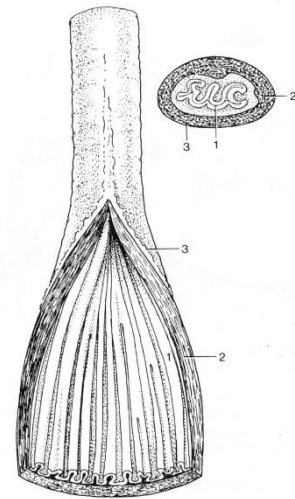
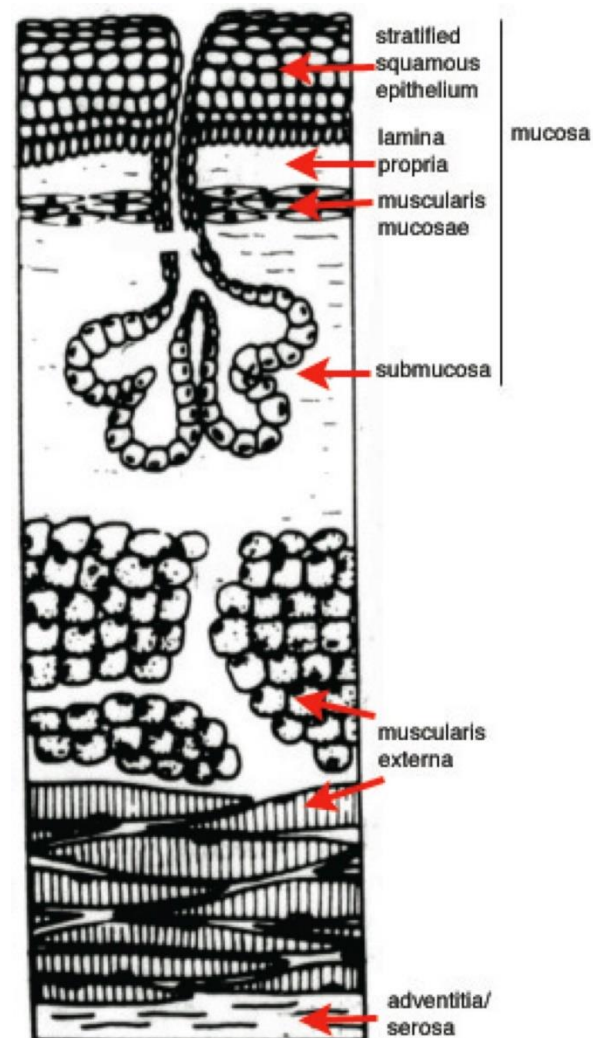


Figure 3-30. Semischematic drawing of the structure of the esophagus, sectioned longitudinally and transversely.

1, Mucosa; 2, muscular layer (longitudinal and circular); 3, adventitia.



Blood supply

- branches of common carotid, bronchoesophageal and left gastric arteries, depending on region

Nerve supply

- branches of sympathetic and vagus nerves

Sites of possible obstruction

- Cranial and caudal oesophagus
- Entrance to thoracic cavity - thoracic inlet
- Over base of heart
- Immediately anterior to diaphragmatic hiatus

Comparative anatomy

Birds:

- on right side of neck in cervical region.
- *crop* - a saccular diverticulum of oesophagus cranial to thoracic inlet.

References:

Dyce KM, Sack WO, Wensing CJG: Textbook of Veterinary Anatomy. Philadelphia, Saunders, 2016.

Jamieson JD: 'The Exocrine Pancreas and Salivary Glands' in Histology: Cell and Tissue Biology, Edited by Weiss, L. New York, Elsevier, 1983, pp 749-773.

Eurell JA, Frappier BL. Dellman's Textbook of Veterinary Histology, 2006.