

# Veterinary Bioscience 1: Digestive system

## Lecture 7 – The simple stomach and abomasum

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### Key words

Simple stomach; abomasum; fundus; body; pylorus; glandular regions; saccus caecus; comparative anatomy

### Intended Learning Outcomes

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

- understand the position in the body of the stomach and its relationship to other structures in the body.
- integrate the discrete regions of the stomach wall with their functions
- recognise species differences in these organs

### THE SIMPLE STOMACH

Dilated part of the alimentary canal in which the processes of digestion are initiated.

The structure of the stomach is determined by the feeding habits of the species:

**Horse, pig and carnivore** have a **simple stomach**

**Ruminants** have a **compound stomach** (the abomasum is their 'true' (glandular) stomach)

#### SIMPLE STOMACH

Is a **musculo-glandular organ** interposed **between** the **oesophagus** and the **small intestine**

Consists of **two distinct parts** that **converge** and join at a **ventral angle**, forming a **C- or J-shape**

**Cardiac, fundic and body** regions form the **larger part** - into which the oesophagus opens

lies mainly to the **left of the median plane**

is well forward **under** cover of the **ribs**

is in **direct contact** with the **liver** and **diaphragm**

is relatively **distensible**

**Pyloric region** is the **second part** which is **narrower**

Has **thicker walls** and is more **constant in appearance**

It **passes to the right** to **continue into** the **duodenum** at the **pylorus**

**Two surfaces** - both variably convex

**Cranial or parietal surface** - is mainly in contact with the **liver** and **diaphragm**

**Caudal or visceral surface** - is in contact with the **intestinal mass**, the **left kidney**, the **pancreas** and the **greater omentum**

**Two curvatures** - the borders between the two surfaces - both run between the cardiac and pyloric openings

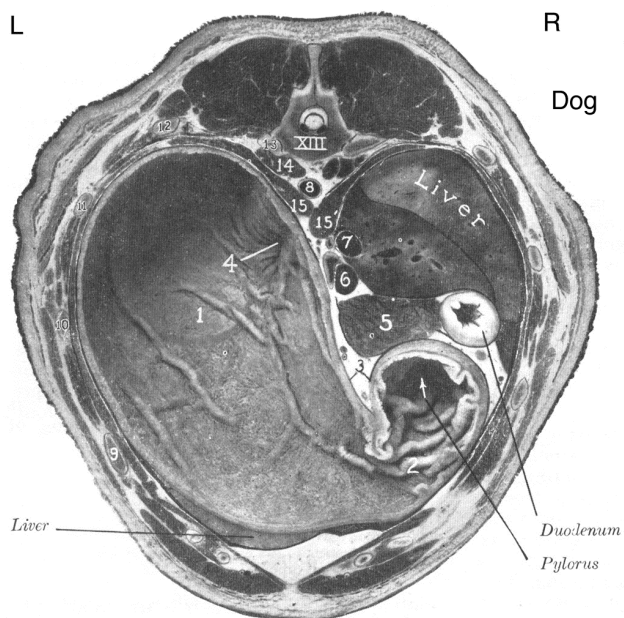
**Lesser curvature** is very **short** and sharply **concave** and is **connected** with the **liver** by the **lesser omentum**

**Greater curvature** is very **long** and **convex** and gives attachment to the **greater omentum** and the **gastrosplenic ligament** which attaches the spleen with the stomach

**Two extremities**

**Cardia** - the oesophageal orifice into the stomach

**Pylorus** - the opening of the stomach into the intestine



Getty 1975

### Relationship to external body wall -

The size and position of the stomach are subject to considerable variation.

### Position:

Lies largely in a **transverse position**, more to the **left of the median plane** than to the right

It forms an **extensive concavity** in the **caudal surface of the liver**

### The external features of the stomach are:

It is C- or J-shaped

### Has a visceral and parietal surface:

#### Visceral surface

Has a variably **convex** outer surface

Lies in **contact with the left lobe of the pancreas**

Is **separated** from the **intestinal mass** and the **left kidney** by the **visceral leaf of the greater omentum**

#### Parietal surface

In the contracted state the stomach lies **in contact with the liver**, in which it produces an extensive gastric impression

The dilated stomach extends beyond the liver chiefly to the left and ventrally.

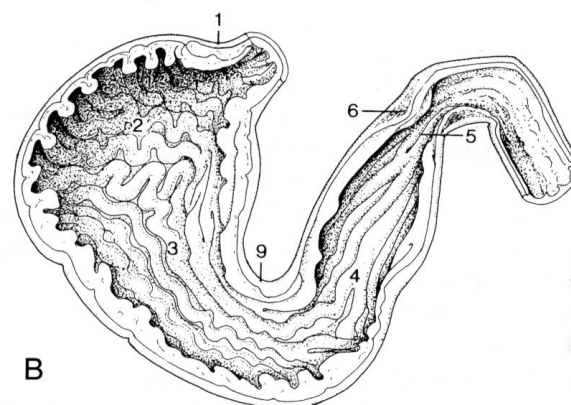
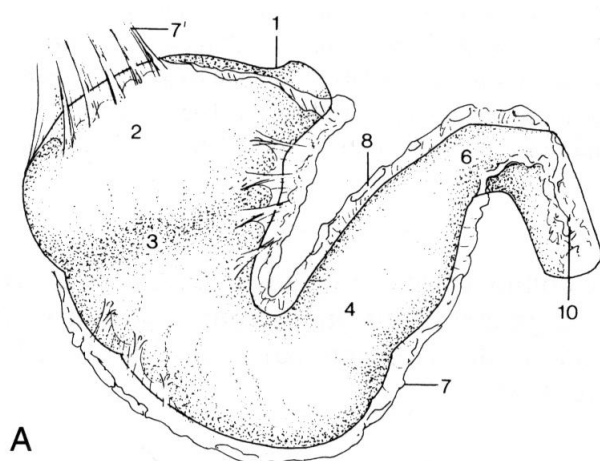
### Has a greater and lesser curvature-

#### Greater Curvature

It is **convex** and extends from the cardia to the pylorus

#### Lesser Curvature

It is **concave** and extends from the cardia to the pylorus; forms a sharp angle.



**Figure 3-37.** Caudal view of the canine stomach. A, Exterior. B, Interior.

1. Cardia; 2, fundus; 3, body; 4-6, pyloric part; 4, pyloric antrum; 5, pyloric canal; 6, pylorus; 7, greater omentum; 7', gastrosplenic ligament; 8, lesser omentum; 9, angular notch; 10, mergence of attachment of greater and lesser omenta.

Dyce et al 2002

## The External Surface of the Stomach is divided into regions:

The cardiac sphincter-the inlet of the stomach from the oesophagus

The larger left part is usually divided into:

**Cardiac region** - usually around the cardiac sphincter

**Fundic region** (or Fundus) - is large and rounded and **usually** the most **dorsal part** of the stomach (above the level of the cardia)

**Body** - usually extending from level of the cardia to the ventral angle

The smaller right directed pyloric region is usually divided into:

**Pyloric antrum** - the more proximal portion

**Pyloric canal** - the more distal portion

**Pyloric sphincter** - the outlet of the stomach into the duodenum

## Supporting membranes of the Stomach:

### The greater omentum

An often extensive serous membrane attached to the **greater curvature** of the stomach

It is rich in fat

It has a **parietal and visceral layer** which encloses a cavity – the **omental bursa**. The opening of the cavity is the **epiploic foramen**

It functions as a storage organ for fat and provides protection

### The lesser omentum

Is a serous membrane that extends from the **lesser curvature** of the stomach and the **initial part** of the **duodenum** to the hilus of the **liver**. **Has two parts** -

**Hepatogastric** ligament

**Hepatoduodenal** ligament - contains the **portal vein, hepatic artery, bile duct and lymphatic duct**

## Blood supply

**Branches of the celiac artery** supply blood to the stomach

The gastric veins **drain into the portal vein**

## Nerve Supply

**Branches of the vagus and sympathetic nerves**

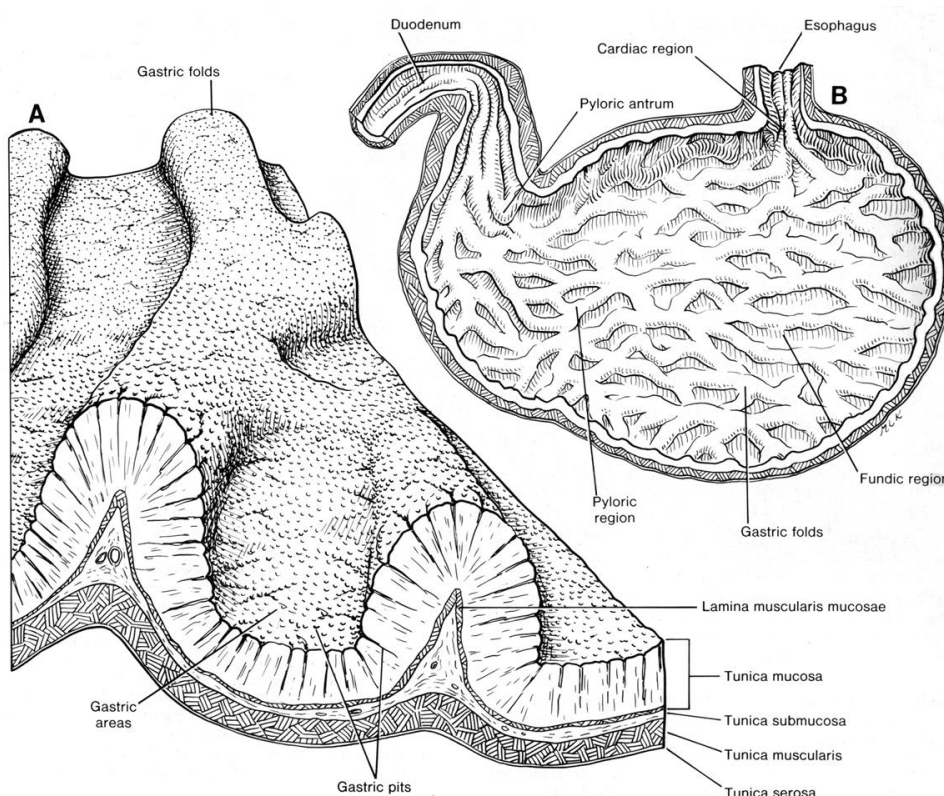


Figure 21.25. A drawing of a longitudinal section of a canine stomach (B). A portion of the wall is enlarged (A).

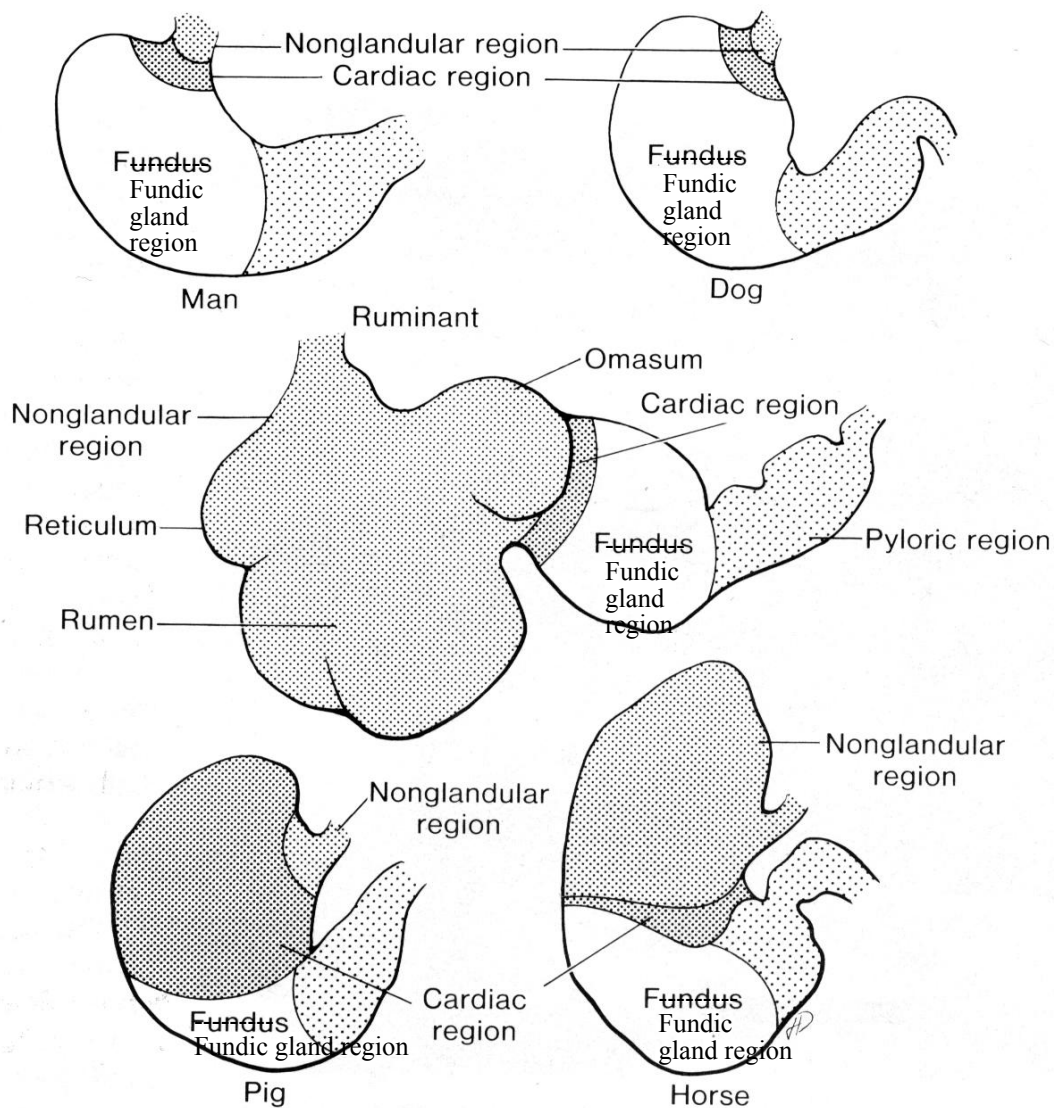
Banks 1986

**Structure of the stomach wall** - is composed of the usual 4 layers of the alimentary canal, but distinctions are made based on the nature of the inner lining of the stomach -whether non-glandular or glandular and the types of glands present. Therefore the lining is **divided into different zones or regions** -based on the distribution of the types of glands in the walls:

**Nonglandular region** – (‘oesophageal’ region): The wall structure is similar to the oesophagus but muscularis mucosa is usually present. There are NO GLANDS present in the wall.

**Glandular region:**

Banks 1986



**Figure 21.28.** A diagram of the distribution of glandular and nonglandular regions of the stomachs of selected animals. The regions indicated are glandular regions. The organs are not drawn to scale.

Glandular regions within stomachs of the domestic species.

Note: ‘Fundus’ here refers to the FUNDIC GLAND REGION, and ‘cardiac region’ refers to the CARDIAC GLAND REGION etc. These are not necessarily the same as the gross anatomical regions discussed on page 2 (except in man and dog).

**Glandular region** - general layout of wall in glandular region is similar:

**Mucosa:**

The mucosa is thrown up into longitudinal folds - **gastric folds or rugae** and the surface epithelium invaginates to form **gastric pits** -lined by **mucus secreting simple columnar** surface epithelium. Function of the mucus is to protect the gastric mucosa (may produce bicarbonate as well, especially in cardiac and pyloric gland regions)

**Tubular Glands** are present in the lamina propria, which extend to the **muscularis mucosa**. They open into the base of the gastric pits. May also see lymphoid follicles in the lamina propria.

**Submucosa:**

**No glands;** Rich in blood vessels and nerves, mainly collagen fibres.

**Muscularis externa:**

Has **3 incomplete layers of smooth muscle, which also** contributes to the cardiac and pyloric sphincters.

Inner- oblique

Middle- circular- helps form the thick ring of the pyloric sphincter and the weaker ring of the cardiac sphincter

Outer- longitudinal- is a very thin layer.

**Serosa:** A serous membrane- reduces friction.

It is reflected from the surface of the stomach to continue in the omenta.

**Based on types of cells present** in the tubular glands of the mucosa, the luminal surface of **the glandular region is divided into -**

**Cardiac zone -**

Gastric pits are lined by **simple columnar epithelium- produce mucus**.

Glands are short branched and coiled, composed of **mainly mucous cells** - usually cuboidal to low columnar

**Fundic zone -**

Gastric pits are lined by **simple columnar epithelium- produce mucus**

Glands -tubular and branched and divided into neck, body and base regions

Cells in gland wall-

**Mucous neck cells** - cuboidal to low columnar cells, lining the lumen in the upper 1/3 of gland. These cells produce mucus. They have flat basal nuclei, cytoplasm slightly more basophilic than surface epithelium.

**Chief cells** - These line the lumen in body and base of gland. They produce enzymes (pepsinogen).

They are the most numerous cells in fundic glands, are cuboidal to pyramidal in shape, with a spherical basal nucleus. Their basal cytoplasm is basophilic- due to extensive RER, and they have an apical cytoplasm- 'lacy' vacuolated appearance

**Parietal cells** – are present in neck body and base of gland; these produce HCl.

They are large and occur singularly (less numerous). They have spherical nuclei, and a deep eosinophilic cytoplasm - due to extensive mitochondria. Pyramidal shape - (narrow apex of cell, base of cell bulges from the outer surface of the gland).

**Endocrine cells** - produce gastrin, secretin etc; difficult to identify with H&E.

Also includes ECL (enterochromaffin-like) cells: secrete histamine.

**Pyloric zone -**

Gastric pits are much deeper- maybe 1/2 the thickness of the mucosa; glands are branched, coiled and short  
Cells in gland wall - **mucous cells** – (flat basal nuclei, pale staining apical cytoplasm).

## Comparative aspects

### Dog:

Is **C-shaped**

Is **relatively large** (average 2.25 litres)

#### The **left part** -

Is large and rounded and comprises the cardiac, fundic and body regions

**The cardia** lies just to the **left** of the median plane **ventral to the 11<sup>th</sup> or 12<sup>th</sup> thoracic vertebrae**.

The most dorsal part the **fundus** usually lies **under the vertebral ends of the 11<sup>th</sup> and 12<sup>th</sup> ribs**

#### The **right part** -

The **pyloric region** is **small and cylindrical** - usually lies **opposite to the ventral part of the 9<sup>th</sup> rib or intercostal space** and a variable distance to the **right** of the median plane

It is **related to the portal fissure of the liver and the pancreas**

When **empty** the stomach does not contact the abdominal wall and **lies cranial to the last rib**. The empty stomach is **separated from the ventral abdominal wall by the liver and intestine**.

When **moderately distended** it lies against the xiphoid and the left hypochondrial portions of the abdominal wall caudal to the liver.

When **completely distended** (especially in pups) it lies largely in contact with the xiphoid and umbilical regions ventrally and the right and left lateral portions of the abdominal wall and reaches caudally to a transverse plane **just caudal to the umbilicus**.

The Mucosa contains three distinct regions

**Cardiac glands** are found in a very narrow pale zone around the cardiac opening and scattered along the lesser curvature

The **Fundic gland** region has a thick reddish brown mucosa which lines about 2/3 of the stomach and has prominent longitudinally orientated rugae

The **Pyloric mucosa** is thin and pale and is often stained by regurgitated bile at post-mortem.

The **greater omentum** is **very extensive** and may contain much **fat**.

When the abdomen is opened ventrally it covers the entire intestinal mass, extending from the greater curvature of the stomach to the pelvic inlet.

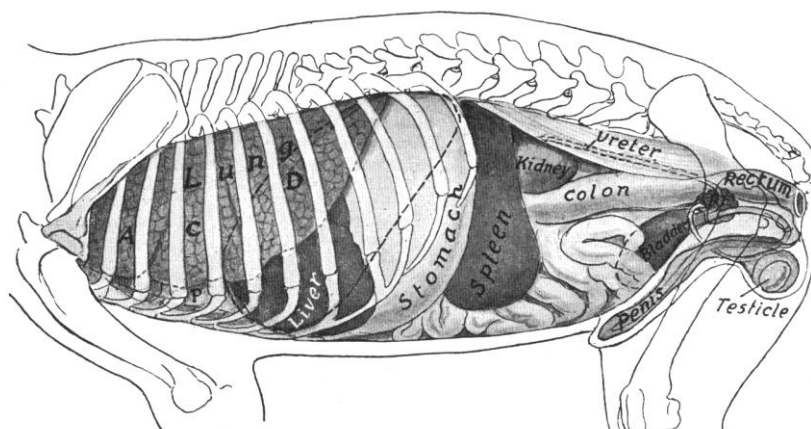


FIGURE 51-22. Projection of viscera of dog (male) on body wall; left side.

A, C, D, Apical, middle and diaphragmatic lobes of lung; P, pericardium; Pr, prostate. Costal attachment and median line of diaphragm are dotted.

Getty, 1975

**Cat** - similar to dog in shape, but is more elongated

## Horse:

Sharply curved **J-shape**

Is **relatively small** (5-15 litres)

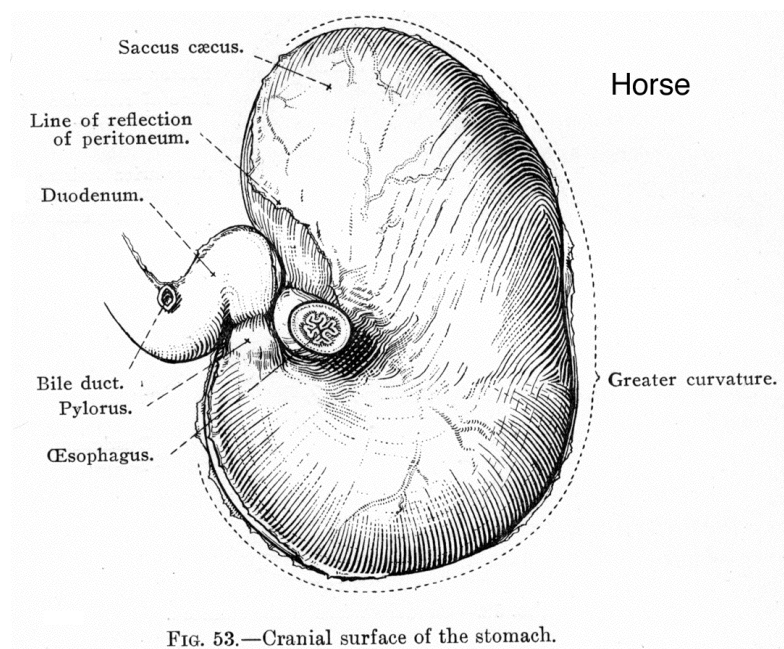
Is situated in the mainly left dorsal part of the abdominal cavity

**Fundus** is extensive, forms a **large non-glandular sac** - the **saccus caecus** - surface is smooth white or yellowish in colour.

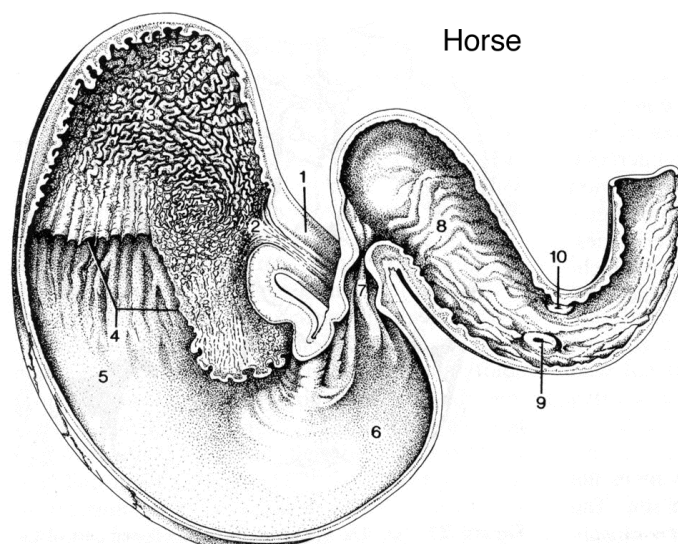
The cardiac sphincter is very strong and the **oesophagus enters at an acute angle** such that the cardia closes when the stomach expands – these are two reasons why horses are **not able to vomit** (except in extreme circumstances).

**Internally**, the saccus caecus is separated from the rest of the stomach by a mucosal fold-**the margo plicatus**-marks the **boundary between the non-glandular and glandular regions** of the gastric mucosa (may see craterlike perforations caused by the larvae of bot flies in this region)

The **greater omentum is relatively small in the horse** and is usually not visible when the abdomen is opened - it is usually folded up in the space between the stomach and the intestine



Bradley 1922



**Figure 21-9.** Interior of the stomach and cranial part of the duodenum.

1, Esophagus; 2, cardiac opening; 3, fundus (blind sac); 4, margo plicatus; 5, body; 6, pyloric part; 7, pylorus; 8, cranial part of duodenum; 9, major duodenal papilla within hepatopancreatic ampulla; 10, minor duodenal papilla.

Dyce et al 2002

**Pig:**

Irregular **J-shape**

Is **relatively large** (~ 9 litres)

The left extremity - the **fundus** - **has** a flattened conical pouch **the diverticulum** (= diverticulum ventriculi) the apex of which projects caudally

The **mucosa** contains **four distinct regions**:

**The proventricular region -**

Lies around the cardia

Is oesophageal in character

Presents a number of folds

Is **non-glandular**

Sharp line of demarcation between it and the rest of the stomach

**Cardiac gland region**

Mucosa is **pale grey** in colour and **soft and thin**

Extends to the middle of the stomach - lines the gastric diverticulum, fundus and ~1/2 the body of the stomach

**Fundic gland region**

Mucosa is mottled brownish red in appearance and thick

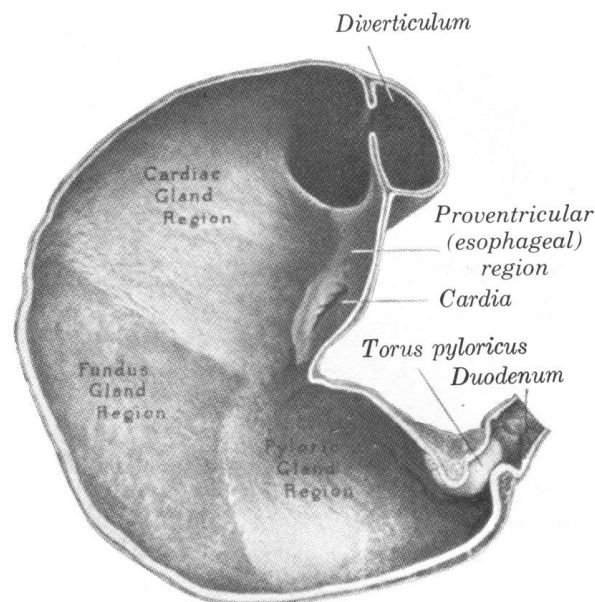
Is not highly folded - and lines the remainder of the body

**Pyloric region**

Mucosa is pale and thin

Mucosa is thrown up into a number of irregular folds

The **torus pyloricus** - is a **projection** of tissue **from** the **wall of the lesser curvature into the pylorus**. It is highly glandular and has a strong fibromuscular/ muscular/fat layer. **It assists the pyloric sphincters** to close the pyloric opening.



Getty 1975

FIGURE 40-16. Frontal section of stomach of pig.



## Birds:

Has two distinct parts separated by a constriction - the **isthmus**

**Proventriculus** - small cranial glandular stomach

Elongated spindle-shaped organ

Mucosa is reddish in colour

Ducts of the mucosal glands open on visible papilla which project into the lumen

**Gizzard** (Ventriculus) - large caudal muscular (smooth muscle) stomach

Large biconvex oval shaped very thick muscular organ

Mucosa is thick, glandular and thrown into folds

Divided into three parts:

**Craniodorsal blind sac** receives the opening of the proventriculus and the duodenum

**Body** - main part

**Caudoventral blind sac**

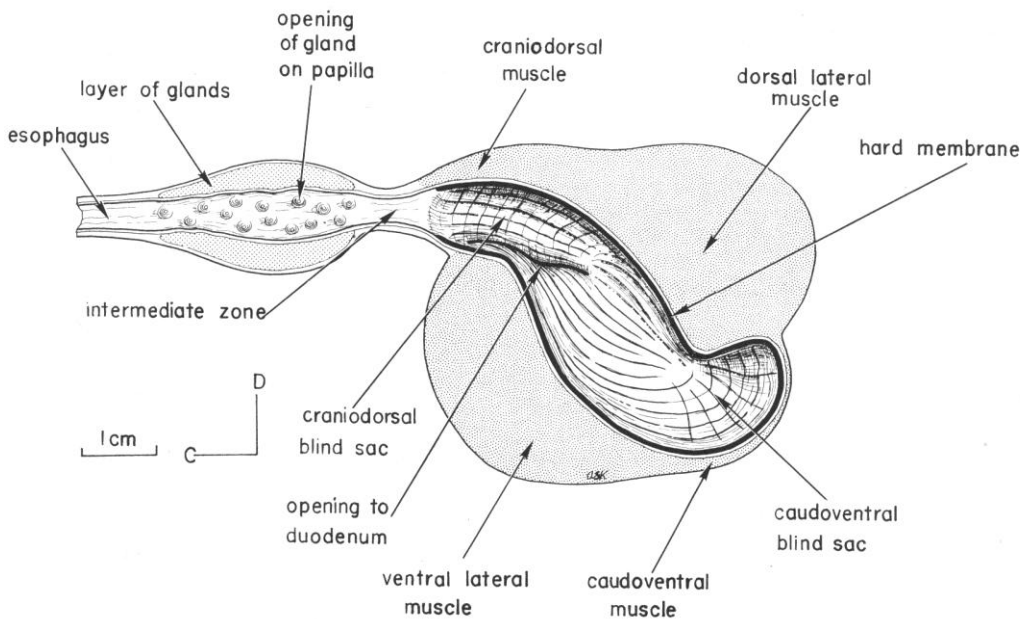


FIGURE 63-13. Longitudinal section of stomach of the chicken.

The cranial glandular part of the stomach is separated from the caudal muscular part by a short intermediate zone. D, Dorsal; C, cranial.

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## Points to think about:

The general position of the stomach in the abdomen of the dog, and its relationship to other abdominal structures and organs.

Think about the change in position of the stomach when it is distended compared to when it is empty.

The gross external and internal features of the monogastric stomach in general. Relate the gross anatomy of the monogastric stomach to its function.

Compare and contrast the gross anatomy of the stomach of the horse and the dog.

The internal features of the pig stomach.

