Comparative Anatomy of Stomach

SEM IV ,CC- 8

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Embryonic Digestive Tract:

Archenteron:

The embryonic archenteron becomes the lining of the adult digestive tract and of all its derivatives. Splanchnic mesoderm adds layers of connective tissue and smooth muscles around the archenteron. Ectodermal invagination of the head forms the stomodaeum leading into oral cavity, and a similar mid-ventral ectodermal invagination forms proctodaeum, which leads into the hindgut.

The stomodaeum becomes the adult buccal cavity and gives rise to teeth enamel, epithelial covering of tongue, glands, e.g., mucous, poison and salivary, etc., and Rathke's pouch of anterior pituitary gland. The proctodaeum forms either a small terminal part of the cloaca in lower vertebrates and rectum in mammals.

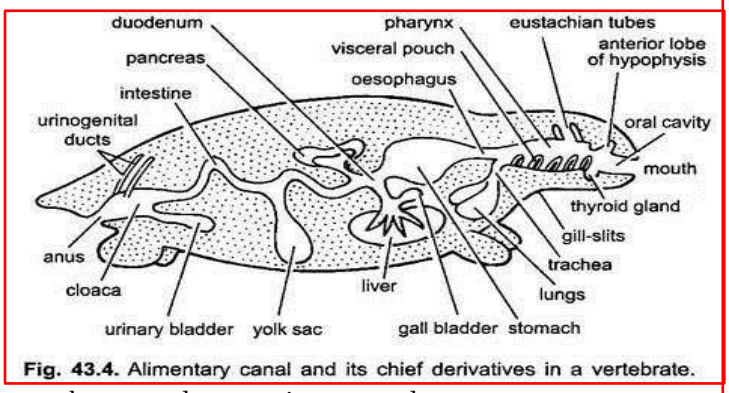


Fig. 43.4. Alimentary canal and its chief derivatives in a vertebrate.

The alimentary canal in embryos from stomach to cloaca is attached to the dorsal body wall by a double fold of peritoneum, called the dorsal mesentery, and to ventral body wall by a ventral mesentery. In adults, dorsal mesentery persists but the ventral mesentery disappears leaving only in the region of liver and urinary bladder.

Digestive Tract of Adult:

The digestive tract differentiates for different functions into the following regions- mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine, large intestine and cloaca. Following outgrowths arise from the digestive tract- oral glands, Rathke's pouch, thyroid gland, gill-clefts, tympanic cavity, thymus and other glands of gill-clefts, trachea, lungs, swim bladder, liver, pancreas, yolk sac, and urinary bladder.

Stomach:

There is practically no stomach in cyclostomes, chimeras, lung fishes and some primitive teleost fishes, since it has no gastric glands, but *in most fishes and tetrapoda it is dilated for storage and maceration of solid food, and digestion of food because it contains gastric glands.*

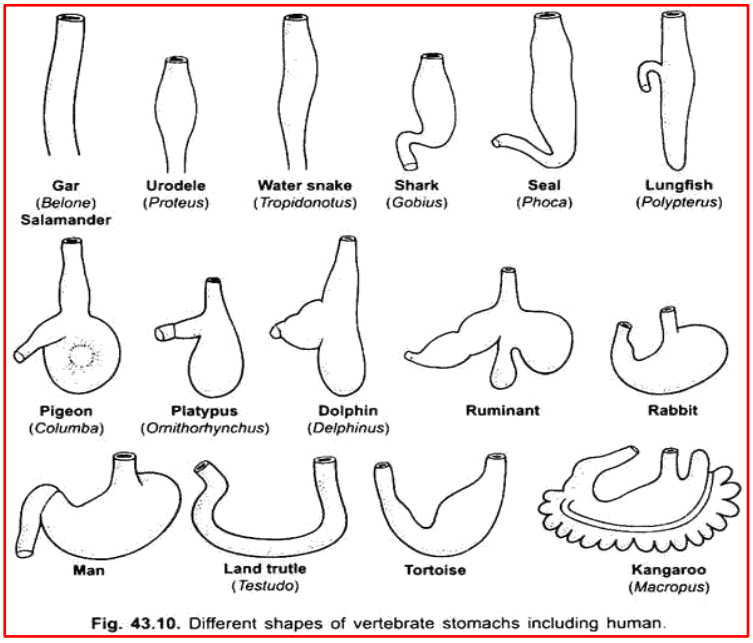


Fig. 43.10. Different shapes of vertebrate stomachs including human.

The first part of the stomach, next to the oesophagus, is the cardiac region and the lower end near the intestine is the pyloric region, which has a pylorus or pyloric valve in which the mucous membrane lining is surrounded by a thick sphincter muscle which regulates the opening and closing of the pyloric stomach into the intestine.

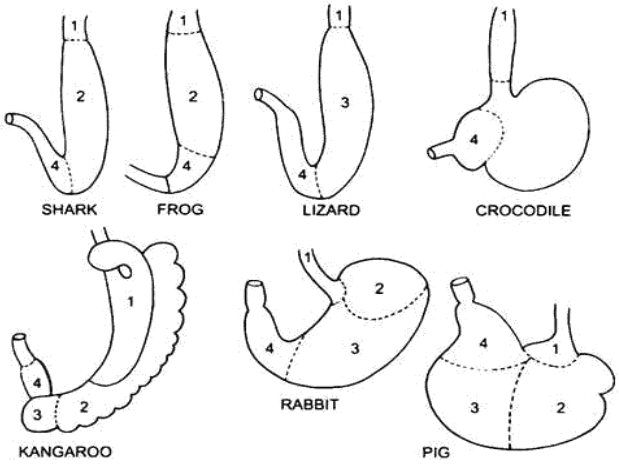


Fig. 43.11. Stomachs of some vertebrates showing different glandular regions. 1–oesophagus; 2–cardiac region; 3–fundic region; 4–pyloric region.

Stomach is straight in cyclostomes, gar, Belone, etc., and *spindle-shaped* in Proteus, Necturus, some lizards and snakes. In turtles and tortoises, it is a wide curved tube, and in elasmobranchs the *stomach is J-shaped*. In crocodiles and birds the *stomach has two parts, a proventriculus with gastric glands, and a highly muscular gizzard*, which represents the pyloric region and has a hard, cornified lining for grinding food.

In *mammals the stomach lies transversely and may be a simple sac or divided into 3 regions*, namely cardiac, fundic and pyloric and each region has its gastric glands. In many ruminants the stomach has four chambers- a rumen, reticulum, omasum and an abomasum. It is claimed that the first three chambers are modifications of the oesophagus, and abomasum is the true stomach representing the cardiac, fundic, and pyloric parts of the stomach.

It has been shown embryologically that all four chambers are modified regions of the stomach. In camels, there is no omasum, the rumen and reticulum have pouch-like water cells which were once believed to store water, but they are probably digestive.

Histologically, the stomach has the typical parts of the alimentary canal, but it has two peculiarities, the muscularis mucosa is made of an outer longitudinal layer and an inner circular layer of muscles. The epithelium lining is thick with several types of glandular cells forming gastric glands of three types called cardiac, fundic, and pyloric gastric glands.

The cardiac and pyloric glands secrete only mucus from their surface cells. Fundic glands (or cardiac glands in some) have three kinds of cells, mucous neck cells produce mucus, oxyntic cells produce hydrochloric acid, they may be present in the cardiac region also, zymogen cells or peptic cells secrete pepsin.

In most animals the zymogen cells also secrete two proenzymes called propepsin and prorennin which are converted by hydrochloric acid into pepsin and rennin respectively. The secretions of all stomach cells form a mixture called gastric juice.

Stomach in Mammals:

The stomach in mammals is transversely arranged and in most forms they take a saclike form. It is divided into two regions, namely cardiac and pyloric. The cardiac part is adjacent to the oesophagus and secretes mucus. The posterior part of the stomach leading into small intestine, called pyloric region. The opening at the pyloric end is guarded by a valve, called pyloric sphincter.

The inner concave side of the stomach is called lesser curvature and outer convex surface is called greater curvature. The sac like bulge lies to the lateral of the cardiac region, called fundus. The main middle part of the stomach is called corpus. The inner surface of the stomach is raised by a number of longitudinal folds, called **rugae.**

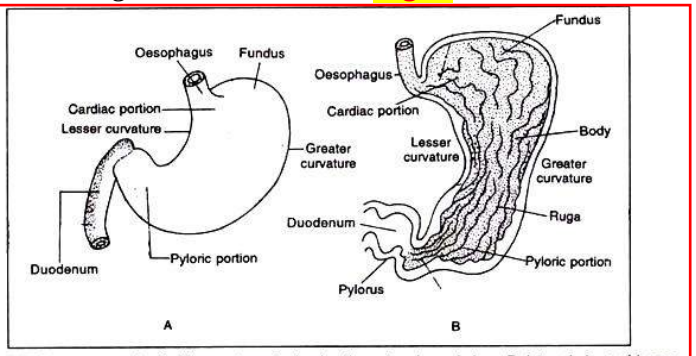


Fig. 10.133 : Human stomach : A. Human stomach showing the external morphology, B. Internal views of human stomach.

The above description is of human beings and the terms are applicable in other mammals. The wall of the mammalian stomach consists of 4 layers, namely:

(i) Serosa:
Is formed of squamous epithelium

(ii) Muscular coat:
Is formed of outer longitudinal muscles, middle circular and oblique muscles

(iii) Sub-mucosa layer:
Is composed of connective tissue and

(iv) Mucous layer.

Glands in the different regions:

The glands that are found in the stomach have been named according to their location. The glands located on the cardiac part of the stomach are called cardiac glands. Those located on the fundus and pyloric parts are called fundic and pyloric glands respectively. The fundic glands are of greatest importance in digestion. There are three types of fundic glands.

They are mucous neck cells, chief or zymogen cells and parietal or acid-secreting cells. The secretion of the stomach is known as gastric juice. It contains mucus, hydrochloric acid, pepsin, renin and gastric lipase. The concentration of gastric hydrochloric acid in human gastric juice varies from 0.05 to 0.3 per cent. In dog this concentration may be as high as 0.6 per cent.

Stomach in Different Groups:

A true stomach is wanting in monotremes and is represented by a wide sac-like structure. The inner lining is devoid of gastric glands. In platypus (Ornithorhynchus) the two parts, namely cardiac and pyloric, are almost fused along the lesser curvature, and appear as a wide sac.

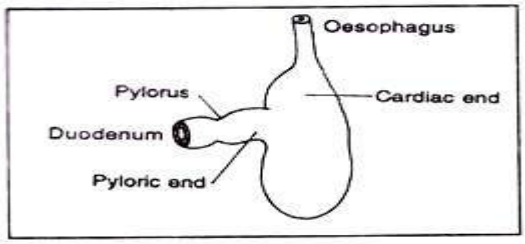


Fig. 10.134 : Stomach of a monotreme (*Platypus*).

In kangaroos (Macropus), the stomach is a large, sacculated non-glandular chamber and the cardiac chamber is divided into many but not as in ruminant artiodactyles.

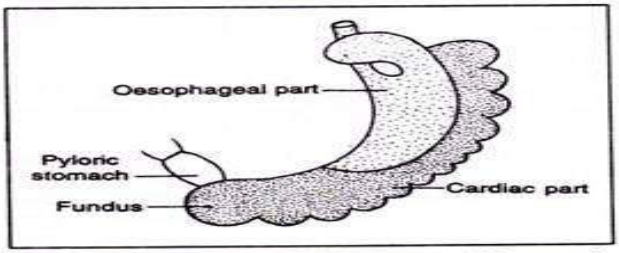


Fig. 10.135 : Stomach of a Kangaroo (*Macropus*).

In many rodents, lagomorphs, in some monkeys and in man, the cardiac and pyloric regions are marked by a constriction in between them. Such stomach is known as hourglass stomach. In rodents and lagomorphs, the food is passed twice through the alimentary canal (caecotrophy). The stomach takes part in this habit.

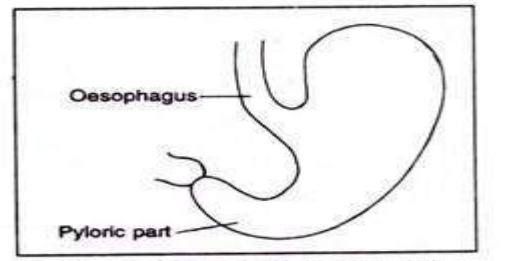


Fig. 10.136 : Stomach of a hare (*Lepus*).

In the blood sucking bat Desmodus, the pyloric part has become elongated to form a caecum-like structure for storage of sucked blood.

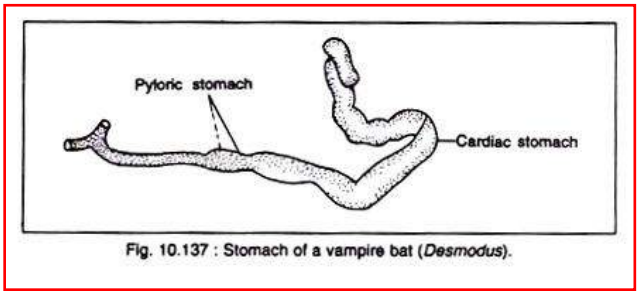


Fig. 10.137 : Stomach of a vampire bat (*Desmodus*).

In pangolins (Manis), the pyloric region of the stomach acts as the gizzard of birds that contains a quantity of stones.

In the foetal pig the stomach possesses an oesophageal diverticulum that evagiriates near to the oesophagus.

The stomach of edentates is of intermediate type and a similarity is seen as monotromes. The stomach of herbivorous mammals is comparatively larger and complicated than the carnivores.

Stomach of Ruminating Mammals

Stomach of ruminating mammals is very complex. The stomach is constituted of *4 separate chambers. They are rumen (= paunch), reticulum or honeycomb, omasum (= psalte rium or many plies) and abomasum (= reed) .*

Ruminant:

A group of placental mammals with a rumen, a specialised extensive digestive tract that processes plant material.

Origin:

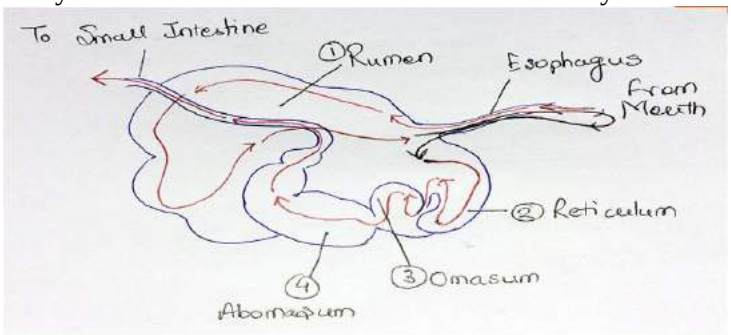
The first three chambers — rumen, reticulum and omasum arise from the oesophagus and only the fourth chamber, the abomasum is the actual derivative of the stomach.

Rumen:

Rumen is the first and the largest chamber of the stomach. It is also called paunch. It has low muscular folds and mucus membrane is beset with numerous short villi. The internal lining is non-glandular and contains stratified epithelium. E. M. structure of rumen epithelium consists of basement membrane between the epithelial and connective tissues.

Reticulum or Honey comb:

The chamber is much smaller than the first. Its mucous membrane has raised up into a number of anastomosing ridges, hence the name reticulum, also called honey comb because its walls are with a honey combed



texture.

Omasum or Psalterium:

The muscular ridges occur as overlapping leaves, hence the name resemble a book such as the psalter or book of psalms used in religious service. Omasum is lined by a stratified epithelium whose thin layer is keratinized.

Abdomasum or reed or true stomach or rennet:

The chamber is smaller than the rumen but larger than the reticulum. It possesses a smooth vascular and glandular mucous membrane with peptic glands. This chamber is the true stomach for its nature.

Process of rumination:

Rumination is the re-mastication of plant material together with microbial fermentation in ruminants. The rumen serves mainly as storage organ. The cattle feed fairly rapidly and fills the rumen with grain, grass and other herbage. The food within the rumen is churned by muscular contraction and undergoes certain bacterial fermentation during its stay in the rumen.

Food from the rumen passes by degrees into the reticulum or directly to the oesophagus and hence to the mouth by a process of retro-peristalsis. Such food regurgitated into the mouth is called cud or bolus. When the cud is well-masticated and thoroughly mixed with the secretion of the salivary glands, it again passes into the rumen.

A new bolus is again formed and chewed and sent back to the rumen. The process is repeated several times and when all the food is well-masticated it passes to the reticulum and then to the omasum and abomasum. The abomasum is provided with gastric glands. This chamber secretes a highly acidic, gastric juice whose pH is 1.05 to 1.32 and kills the microorganisms and initiates the process of digestion.

Camel's Stomach:

The true ruminant stomachs occur under the suborder Ruminantia. The Camel's stomach is different in anatomy and histology with the stomach of ruminants, but their rumination and fermentation are the same like the true ruminants.

In camels the stomach is *three-chambered*, the

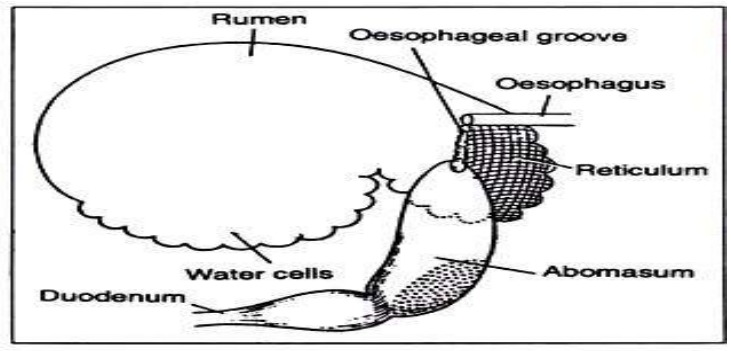


Fig. 10.140 : Stomach of a camel.

omasum being absent. The rumen and reticulum parts of the stomach of camels are provided with pouch-like water cells. Their openings are guarded by sphincter muscles. At one time it was believed that the camels store water in their water cells and make prolonged journey without drinking water.

But the view is no longer tenable. The pouches can by no means hold as much water as would be required by the animal on a prolonged journey through the desert where no water is available. Later studies [Duke (1947), Schmidt-Nielsen (1953-54)] have shown that the camels get their water requirement during journey by the breaking down of the glycogen of the muscles and fat of the hump.

Physiologists have shown that for each 100 gm. of fat oxidised in the body 110 gm. of water is formed. They also have shown that the water cells do contain some metabolic water. The water is pure in nature and helps in moistening the food.