Stomach in Mammals

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1. Introduction to 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 (Fig. 10. 133A). 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. 10.133B).

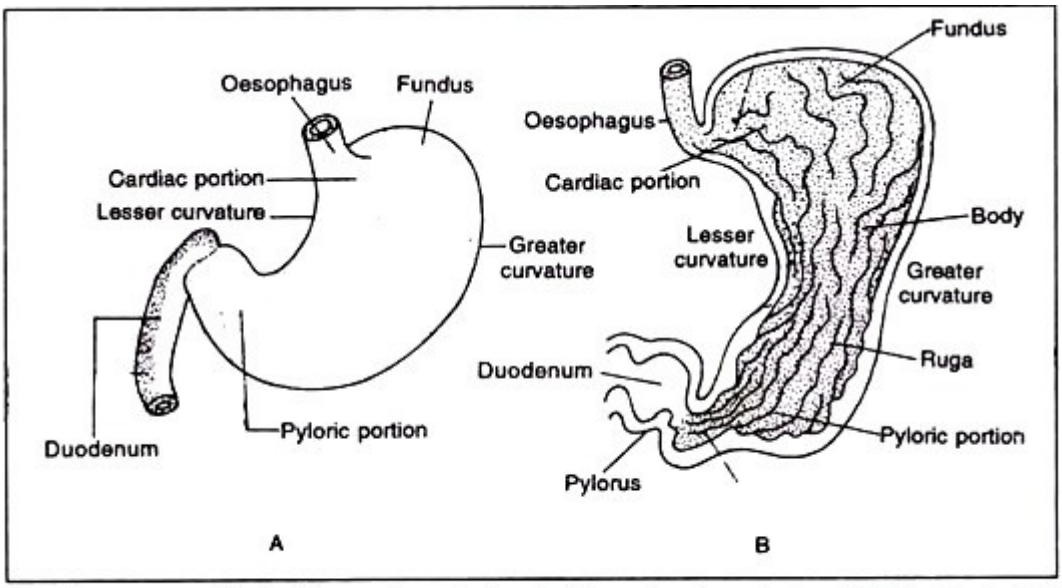

Fig. 10.133 : Human stomach : A. Human stomach showing the external morphology, B. Internal views of human stomach.

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: It is formed of squamous epithelium
(ii) Muscular coat: This is formed of outer longitudinal muscles, middle circular and oblique muscles
(iii) Sub-mucosa layer: It 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.

2. 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).

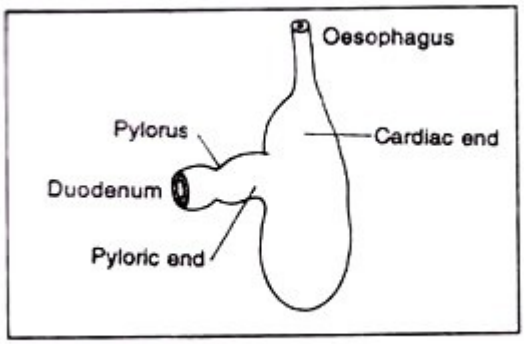

Fig. 10.134 : Stomach of a monotreme (*Platypus*).

In kangaroos (Macropus), the stomach is a large, sacculated non-glandular chamber (Fig. 10.135) and the cardiac chamber is divided into many but not as in ruminant artiodactyles.

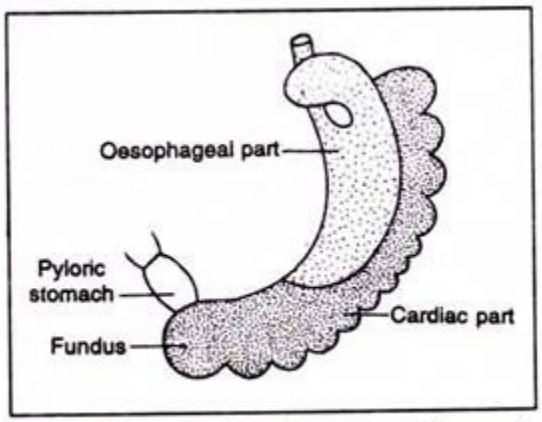

Fig. 10.135 : Stomach of a Kangaroo (*Macropus*).

In many rodents, lagomorphs (Fig. 10.136), 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.

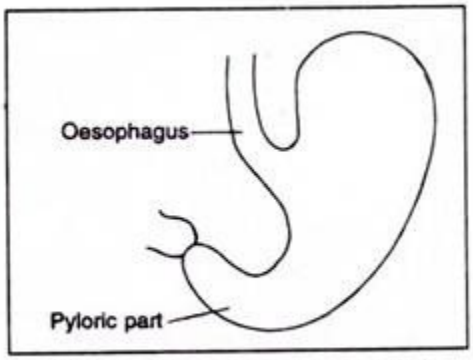

Fig. 10.136 : Stomach of a hare (*Lepus*).

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).

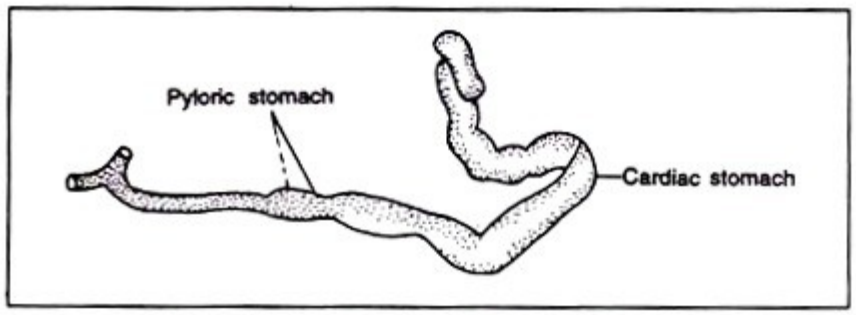

Fig. 10.137 : Stomach of a vampire bat (*Desmodus*).

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.

3. 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) (Fig. 10.139A).

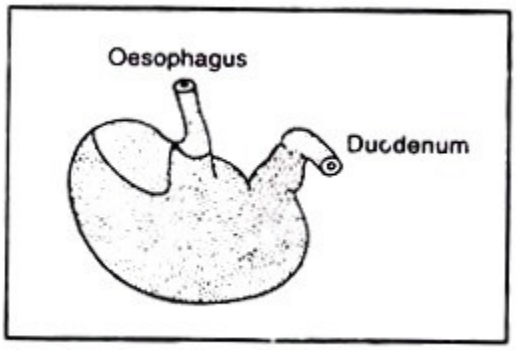

Fig. 10.138 : Stomach of the foetal pig.

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.

Histology 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.

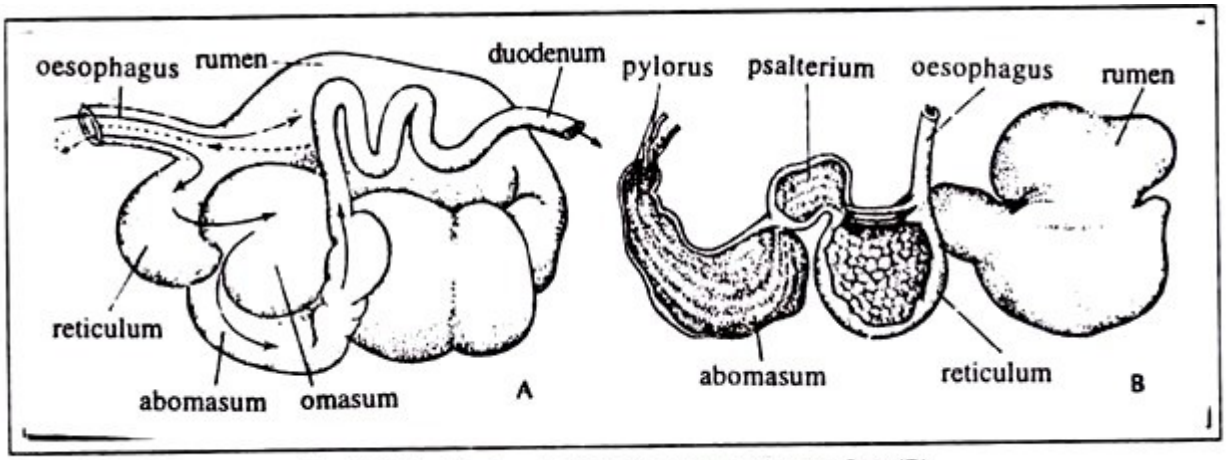

Fig. 10.139 : Ruminant stomach of *Bos* (A) and *Ovis* (B).

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.

4. 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 omasum being absent. The rumen and reticulum parts of the stomach of camels are provided with pouch-like water cells (Fig. 10.140). 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.

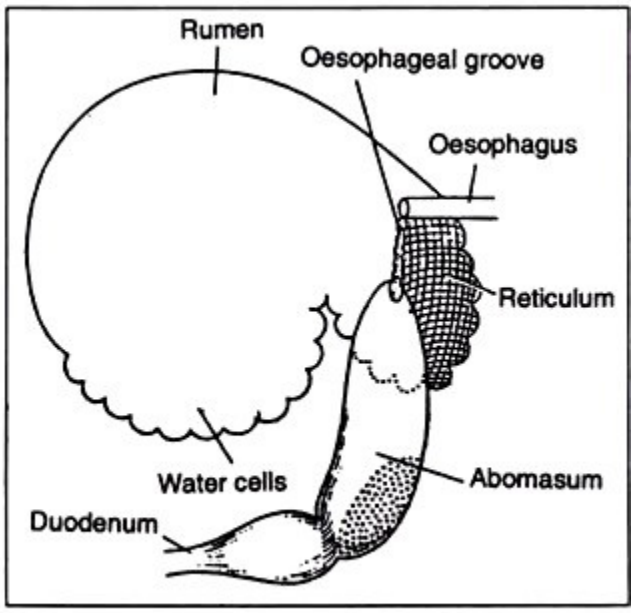

Fig. 10.140 : Stomach of a camel.

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. The stomach of whales and hippopotamus is divided into several chambers.

5. Caecum:

A caecum at the junction of the large and small intestine is present in most mammals. The size and the structure of the caecum vary greatly in different mammalian orders. As a general rule the caecum is larger in vegetarian than in

carnivorous forms. The caecum is large in eutherian rabbits. In hyrax four distinct caeca are present.

Of these the posterior pair bear vermiform appendix. In man, monkey, civet and a few rodents the distal part of the caecum is degenerated and has formed the vermiform appendix. Caecum is simple in monotremes and absent in sloths, cetacea and a few carnivores. Marsupial koala bear the longest caecum of all. It is about 250 cm long. The major digestive glands are the liver and pancreas.

The histological pattern of the liver and pancreas is described below:
Liver:
Units of liver are liver lobules. Each lobule is surrounded by connective tissue materials containing collagen. A particular lobule is composed of polyhedral cells (often bi-nucleate) radiating from a central vein-the hepatic vein (Fig. 10.141).

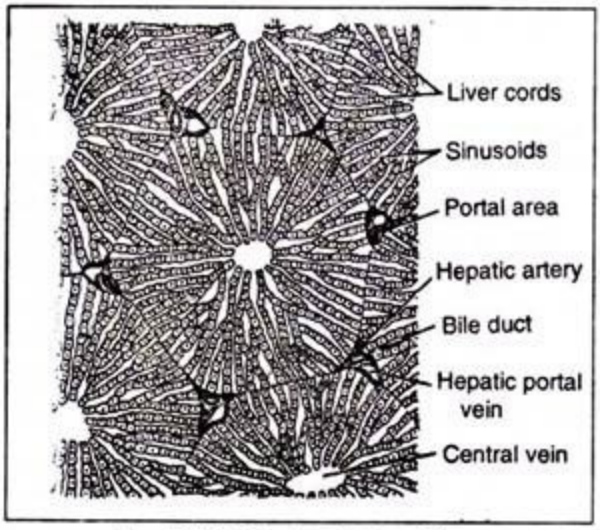

Fig. 10.141 : Sectional view of liver.

Associated with one liver lobule, a portal canal occurs which is composed of a trinity of (a) Portal artery, (b) Portal vein and (c) Bile duct. All these are surrounded by connective tissue materials forming Clisson's capsule.

Pancreas:
Mixed type of gland consisting of two altogether different glandular entities:
(a) Multiple alveolar type (Exocrine):
Each alveolus is walled by truncated pyramidal cells. Nuclei in these cells are situated towards the basal membrane. The alveolar cells have zymogen granules and deeply stained basophilic bodies towards the basement membrane. Presence of some flattened cells in the lumen of alveolus (centroacinar cells) is the characteristic of pancreatic alveolus.

(b) Islets of Langerhans (Endocrine):
Islets include three types of cells, α (alpha), β (beta) and Y (gamma) cells. The gamma cells are regarded to be the precursors of α (alpha) and β (beta) cells. In human Islets a fourth type of cells—the δ (delta) cells have been described. The β-cells produce the hormone— Insulin.

This fact is experimentally attested by causing Alloxan diabetes (treatment of Alloxan, a derivative of Urea, which causes degeneration of P cells). The Islets are special areas in between the pancreatic acini and consist of irregular clumps of cells, capillaries and reticular tissue. Islets are not encapsulated but remain separated by reticular fibres (Fig. 10.142).

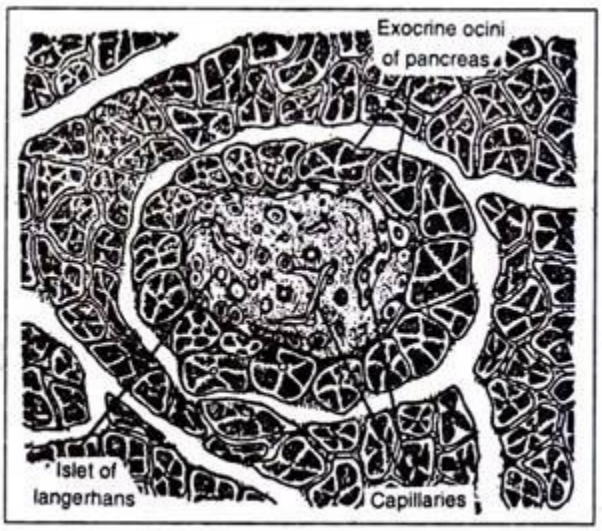

Fig. 10.142 : Sectional view of pancreas.

6. Adaptation of Mammalian Digestive System:
In course of their evolution, the mammalian digestive systems became adapted to utilize a wide variety of foods. In most of the mammalian species the diet is generalized, but in others diet has become specialised. As a consequence diverse modifications of the mammalian digestive system have been encountered.

The following biological terminologies are used to mean either the mode of feeding or the kind of food taken:
Carnivorous:
Eating animal material, i.e., meat- and flesh-eating. Carnivorous animals are usually called the 'predator'.

Examples:
Coyotes, wolves, minks, weasels, bobcats, tigers, lions, etc.

Durophagous:
This specialisation is meant for handling hard food (e.g., hard-shelled animals).

Frugivorous:
The term frugivorous signifies a diet of fruit. Many bats, specially the 'flying foxes' and flying lemur (Cynocephalus volans) are frugivorous.

Herbivorous:
This term designates a diet of plant material. The ungulates are generally herbivores. The plant-eaters have a long intestine and their stomach may be functionally differentiated into several chambers. Such specialisation has reached its peak in ruminants. Digestion is partially aided by micro-fauna (Bacterial fermentation) which assist in breakdown of cellulose.

Coprophagous:
This adjective refers to the re-ingestion of the expelled pellets and thus passing them through the digestive tract again. It is found in herbivores like pocket gophers, rats and rabbits. Coprophagy is a special adaptation to extend the time for bacterial fermentation.

Insectivorous:
The word insectivorous refers to a diet consisting of insects. It is a type of specialised carnivorous diet.

Examples:
Some bats and all members of the order insectivora feed on insects.

Nectivorous:
This term refers to the animals which feed on nectar and pollens.

Example:
Long-nosed bat (Leptonycteris nivalis).

Sanguinivorous:
This term refers to the diet of blood.

Example:
Vampire bat (Desmodus rotundus).

Omnivorous:
The animals which feed on a great variety of food materials.

Examples:
Human, Bear, Opossum, Pig, etc.

Myrmecophagous:
The animals which feed on ants and termites, e.g., aardvark of sub- Saharan Africa.