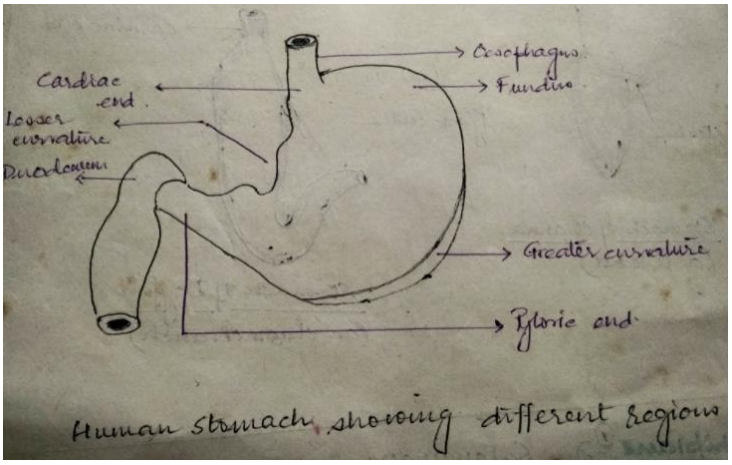
Comparative Anatomy of Stomach in Vertebrates

The stomach is a muscular chamber or a series of chambers between the oesophagus and small intestine, that serves as a receiving site for the recently ingested foods, secrete digestive enzymes and lubricating mucous and macerates food while mixing it with the gastric juice. It is called **true stomach** only when its inner lining contains gastric glands.

Regions or topography of a stomach:

- The stomach is straight when it differentiates in embryos and remains straight throughout life in some basal vertebrates.
- Flexures develop in course of evolution producing J shaped or U shaped stomachs in other vertebrates.
- The stomachs exhibit a concave border or ***lesser curvature*** and a convex border or ***greater curvature.***
- Not only do most stomachs exhibit a flexure but in mammals they undergo a torsion along with their part of dorsal mesentery, twisting in such a manner that stomach and mesentery lie crosswise in the trunk.
- When there is more than one chamber in a stomach, then the first chamber serves the purpose of temporary holding the recently ingested food. Its epithelium is similar to that of oesophagus and have many mucous glands.
- The end of the stomach that lies connected to the oesophagus is the ***cardiac end*** whereas the stomach terminates at the ***pylorus*** which is the opening of the stomach to the duodenum. The opening is surrounded by a ring of smooth muscle the ***pyloric sphincter***.

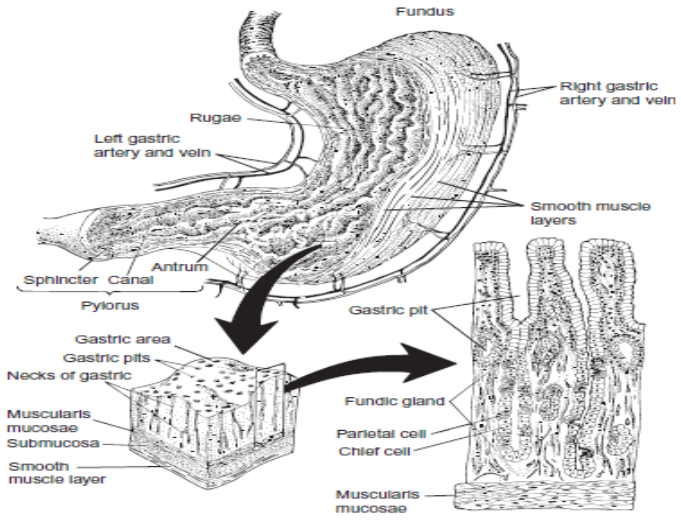


Histology of stomach:

- On the basis of mucosal histology, two regions of the stomach can be distinguished.
- The stomach's **glandular epithelium** is characterized by the presence of **gastric glands.** These are branched, tubular glands, several of which empty into the bases of surface indentations, or **gastric pits.**

- There are three divisions of the stomach—cardia, fundus, and pylorus—based on the relative position and type of gastric gland.
- The **cardia** is a very narrow region found only in mammals, and it marks the transition between the esophagus and the stomach. Its gastric glands, termed **cardiac glands,** are composed predominantly of mucus-secreting cells.
- The **fundus** is usually the largest region of the stomach and contains its most important gastric glands, the **fundic glands.**
- Mucous cells are present in fundic glands, but these glands in mammals are distinguished by their abundance of **parietal cells,** the source of hydrochloric acid, and **chief cells,** the presumed source of several proteolytic enzymes.
- Other vertebrates possess instead oxyntopeptic cells that produce bothHCl and pepsinogen. Upon release into the stomach's lumen, pepsinogen is cleaved by HCl to produce pepsin, an active proteolytic enzyme.
- Before emptying into the intestine, the stomach usually narrows into a **pylorus,** whose mucosal walls hold distinct gastric glands called **pyloric glands.** The pyloric glands are predominantly composed of mucous cells whose secretions help to neutralize the acidic chyme as it moves next into the intestine. Thus, most of the chemical and mechanical processes of gastric digestion occur in the fundus.
- The cardia (when present) and pylorus add mucus.

Smooth muscle bands in their walls act as sphincters to prevent the retrograde transfer of food.



- In addition to a region of glandular epithelium, the stomach of some vertebrates also has a second region characterized by **nonglandular epithelium,** devoid of gastric glands.
- As in some herbivores, the nonglandular region may develop from the base of the esophagus. In other species, such as rodents, loss of gastric glands in the mucosa leaves a nonglandular epithelial stomach in which smooth muscle contractions knead and mix digesta.

- This nonglandular epithelium in rodents also can be keratinized, perhaps as a result of mechanical abrasion from rough foods such as seeds, grasses, and insect chitinous exoskeletons. Chemical insult from digestive enzymes added in the mouth may also cause a keratinized nonglandular epithelium.

Comparative Anatomy:

Agnathans (jawless vertebrates):

I. There is no definite stomach

II. Digestive tract is one long tube from mouth to vent exhibiting no gross differentiation of oesophagus, stomach and intestine

III. The epithelium of the digestive tract is a single layer of cells including mucus secreting goblet cells and flask shaped cells secreting proteolytic enzymes.

IV. The base of each cell is in contact with the underlying vascularised layer of the mucosa from which they receive nourishment.

Fishes:

I. The stomachs of fishes display a wide variety of shapes and the epithelium is sometimes ciliated.

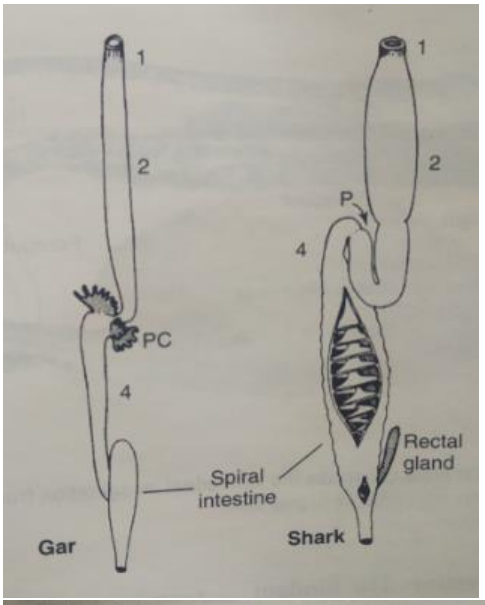
II. The gar stomach is often straight.

III. Sharks exhibit the more common J-shaped stomach i.e. the pyloric end is smaller than the cardiac portion.

IV. The entire stomach of some teleosts is one large caecum(c,d).

V. Chimeras and lungfishes have no definitive stomach or have only that is poorly differentiated and lacks digestive glands.

VI. In some teleosts the loop becomes fused at its inner end in such a way that a bag shaped pouch is formed with the entrance and exit brought close to each other at one side (a, b).



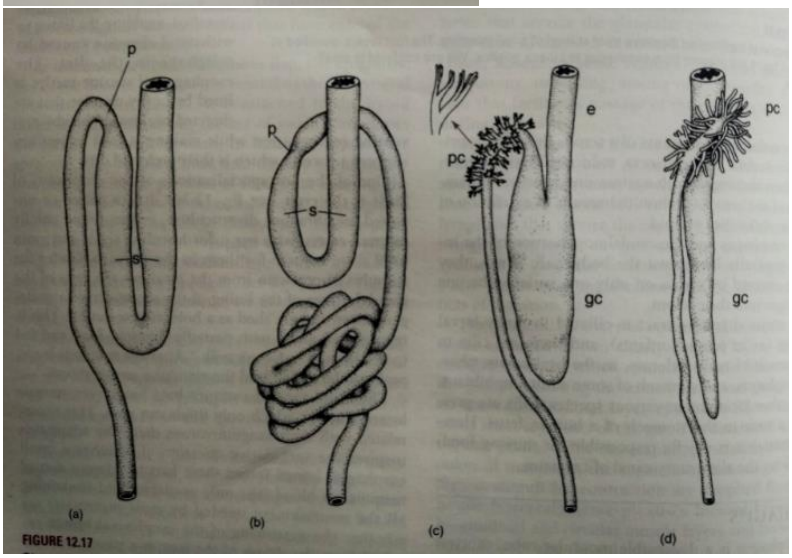
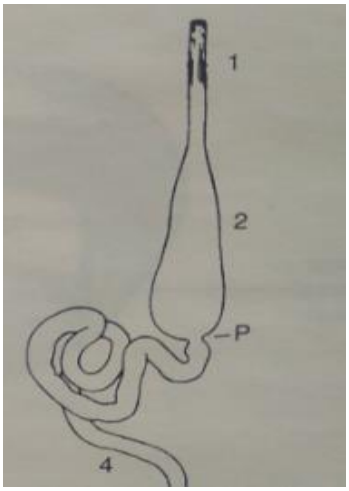


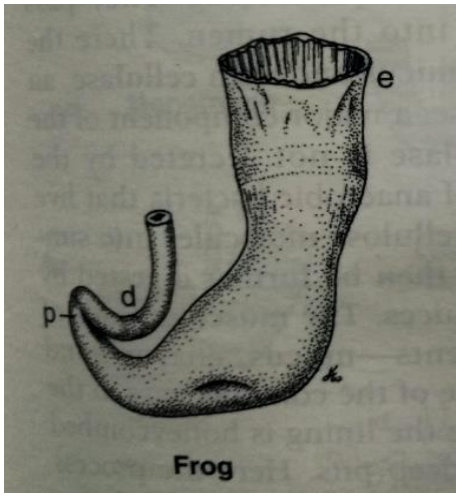
FIGURE 12.17

- **Amphibians:**

I. In salamanders the stomach is a straight spindle shaped tube.

II. In toads and frogs, the stomach is not distinguishable grossly from the oesophagus. Both of the regions are capable of enormous distension.



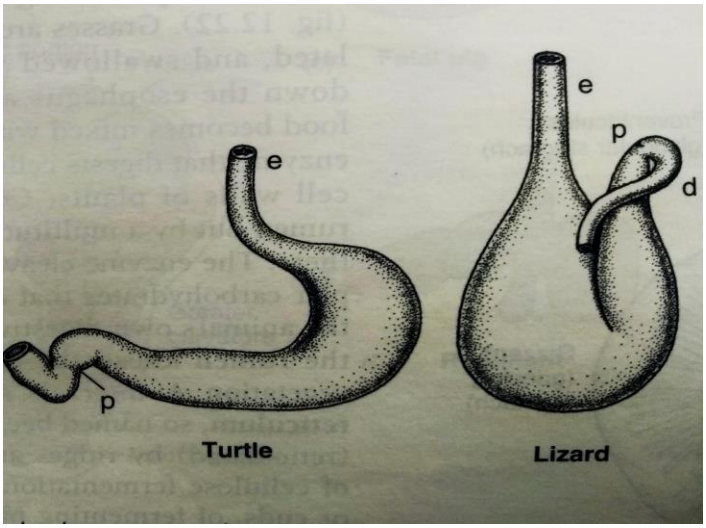


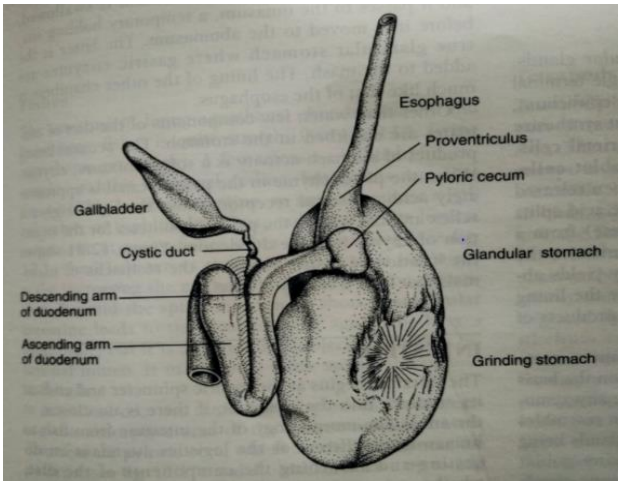
- **Reptiles:**

I. The shape of the stomachs of lizards and turtles are shown in the following figure.

II. Crocodiles have a highly developed stomach, having two parts- proventriculus and gizzard.

III. The proventriculus secretes the digestive enzymes and the gizzad lined with a horny membrane simply grinds and makes a mash of food mixed with gastric secretions.





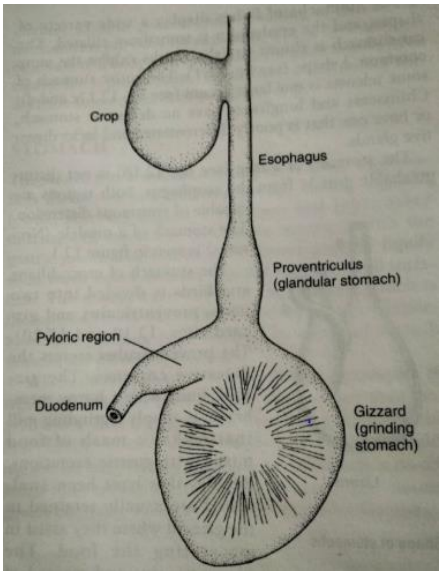
Stomach of Caiman (Small variety of Alligator)

- **Birds:**

I. The stomach in birds have two parts- proventriculus and gizzard.

II. The proventriculus secretes the digestive enzymes and the gizzad lined with a horny membrane simply grinds and makes a mash of food mixed with gastric secretions.

III. The gizzard is best developed in grain eating birds and less developed in carnivorous birds.



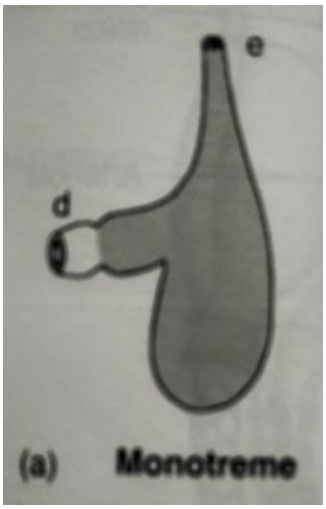
- **Mammals:**

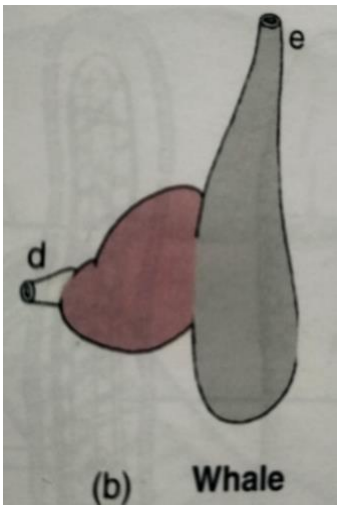
I. In Monotremes, the lining epithelium lacks gland and the stomach mainly serves for the storage purpose. It is therefore ***not considered as a true stomach***.

II. The stomachs of Whales (cetaceans) and Hippopotamus are divided into several compartments.

III. In the porpoise (toothed whales) the stomach is divided into 3 compartments- cardiac, middle and pyloric compartments. **Cardiac compartment** is a spacious chamber having smooth and thick

mucous membrane. The **Middle chamber** is smaller in size having a glandular mucous membrane having a number of complex folds. **Pyloric portion** is long and narrow and is further divided in to a small anterior bulbous portion and a long and narrow posterior portion.





- **Human Stomach:**

I. The region of stomach at the base of the oesophagus is the cardiac portion.

II. Lateral to the cardiac portion is the fundus characterised by an array of gastric glands.

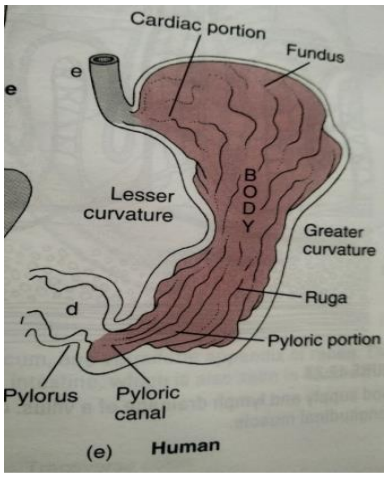
III. The region between the lesser and greater curvature is the body of the stomach and the region preceding is the pyloric portion.

IV. The cardiac and the pyloric portion of the stomach can be distinguished from other regions on the basis of eth histology of their glands.

V. None of the regions have zymogenic cells.

VI. The mucosa in the cardiac region resembles that of eth lower end of oesophagus, the glands being compound tubular with many goblet cells. A few parietal cells are also present.

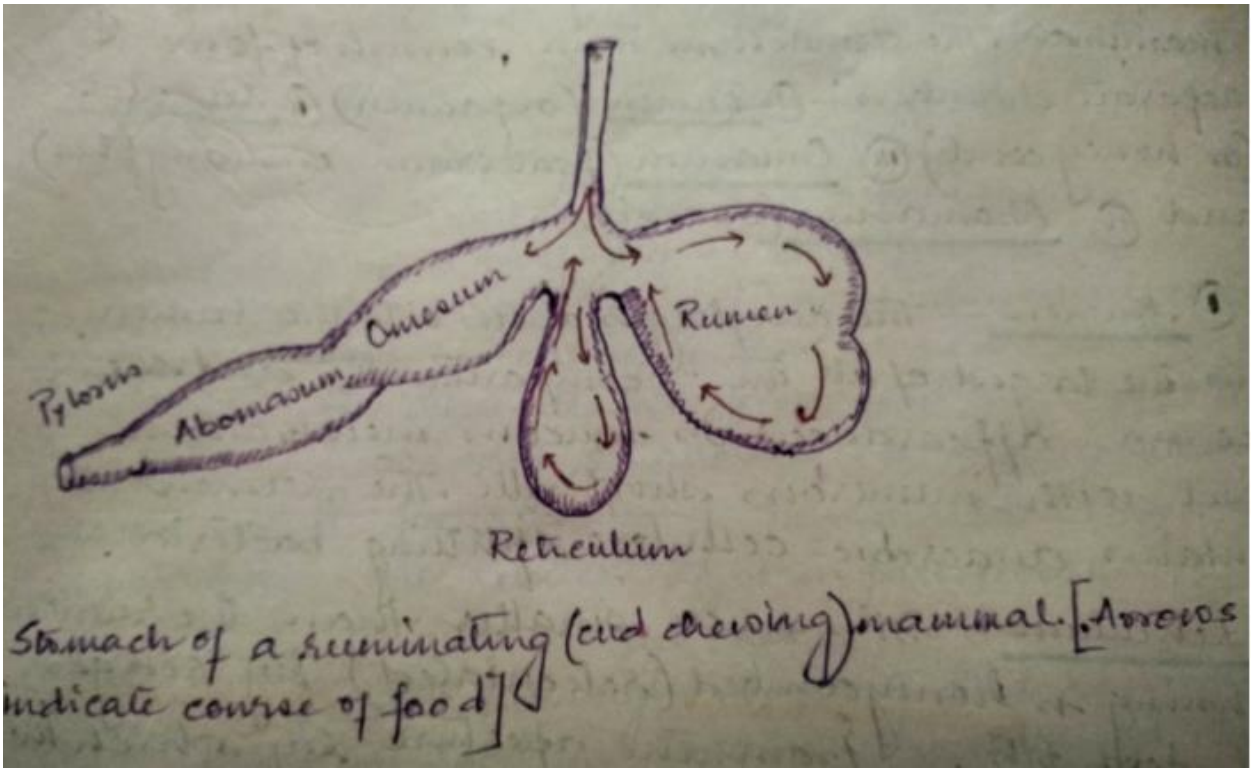
VII. Pyloric glands are simple branched tubular glands extended deeper into the mucosa. They have many goblet cells and relatively few parietal cells. Between the fundus and the pyloric region, the mucosa exhibits typical gastric glands.



- **Ruminant Stomach:**

I. Ruminants have the most complex stomachs among mammals. The stomach in them consists of multiple chambers named Rumen, Reticulum, Omasum, Abomasum.

II. ***Rumen:*** The oesophagus opens into the rumen. It is the largest of all the compartments and sac like in appearance. Its mucous membrane is beset with numerous short villi. The rumen contains cellulose splitting bacteria.



III. ***Reticulum:*** It is much smaller than the rumen. Its lining is honey comb shaped by ridges and deep pits. The aperture by which the reticulum communicates with rumen and to that with which it

communicates with the omasum runs a groove bounded by a pair of muscular ridges which are capable of closing together in such a way as to convert the groove into a canal.

IV. ***Omasum:*** The mucous membrane of this region is modified into overlapping leaf like structures arranged longitudinally.

V. ***Abomasum***:It is smaller than omasum but larger than reticulum. It is the only chamber provided with gastric glands. Here all the three types of epithelia, distinctive of the mammalian stomach-cardiac, fundus and pylorus are present. The lining of abomasum exhibits longitudinal folds.

*In **camels**, the stomach is not much complex because an omasum is lacking. The rumen is devoid of villi. Pouch like diverticula called water packets or water cells arise from both rumen and reticulum. The openings are guarded by sphincter muscles. The water cells contain metabolic water drawn from other parts of the body. Much of it comes from the break down of glycogen stored in muscles and fat stored in the hump.*

Ruminating Mechanism:

1. **In ruminants first the food (grass, grains, wheat paddy etc) are chewed briefly and then hurriedly swallowed with copious saliva and passes into the rumen.**
2. **Then the food passes to the rumen, becomes mixed with mucus and the with cellulase- an enzyme digesting cellulose, a major component of the plant cell wall. Cellulase is secreted by a number of anaerobic enzymes present in the rumen. And breaks cellulose into simpler carbohydrates for easy digestion by the gastric juice of the animal.**
3. **Next the content of the rumen passes to the reticulum and the process of cellulose fermentation continues, and small boluses or cuds of fermenting pulp are regurgitated for further maceration by the teeth.**
4. **Now the thoroughly masticated mash is swallowed and now it passes to the omasum, a temporary holding site.**
5. **Next it is moved to the abomasum, and the mash is mixed with gastric juice for digestion.**