

DIGESTION OF PROTEIN IN MAMMALS

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Digestion is a process that involves physical and chemical breakdown of insoluble complex food materials into soluble simple food materials by the action of enzymes that may be absorbed.

Most animals engulf large piece of food and are macrophagous. The food is converted into slimy ball or bolus in the buccal cavity by the combined action of mastication and mucus of saliva.

In mammals teeth on jaws, tongue, saliva, cheek pouch and jaw muscles help in mastication.

No digestion of protein takes place in mouth.

The food in buccal cavity is called bolus is swallowed.

Swallowing in mammal has three phases

① Buccal swallowing movements are caused by upward and backward movement of tongue.

② The pharyngeal and ③ Oesophageal phase of swallowing are involuntary forcing the food into stomach through oesophagus.

Stomach of mammals are variously modified with their feeding habit.

The stomach of ruminant (eg. Cow, goat) are very massive and made up of four chambers - Rumen, Reticulum, omasum and abomasum.

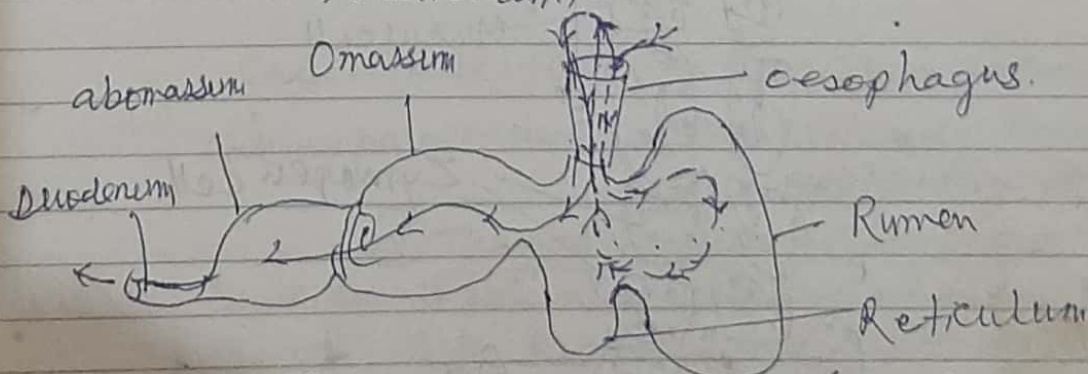


Fig. Stomach of a ruminant (cow)

2. The stomach of non-ruminant consists

of cardiac, body, fundic and pyloric part. The fundic part has gastric glands which secrete digestive juice.

A typical gastric gland is basically an infolding of gastric mucosa deep into the submucosa.

- A gastric gland is mainly consists of:
- (i) a pit open into the stomach lumen,
 - (ii) an isthmus (i.e. neck) containing oxyntic or parietal cell secreting HCl and mucous cells producing mucus and
 - (iii) A base containing zymogen or chief cells secreting pepsinogen, and prorennin.

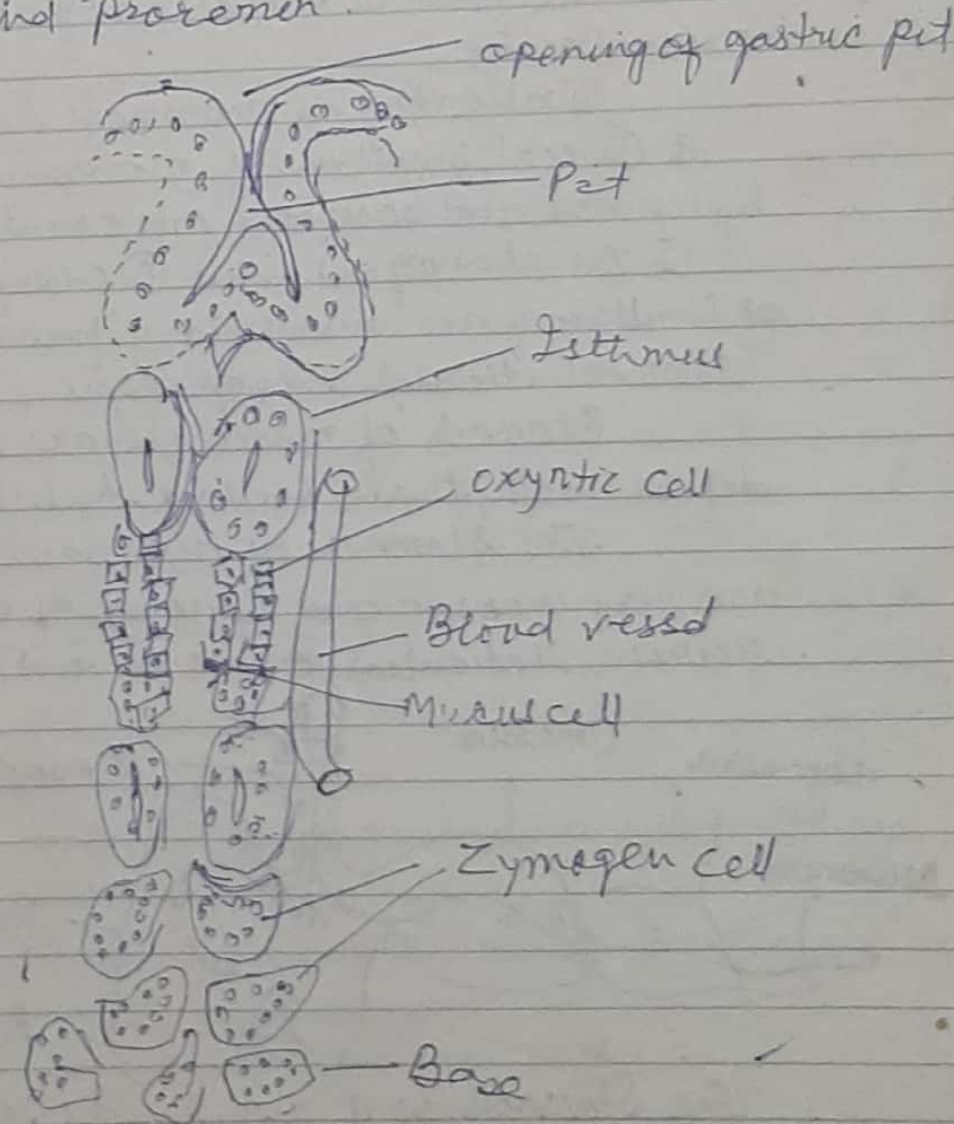


Fig - V.S. gastric gland of Monkey.

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Digestion of protein in Stomach :

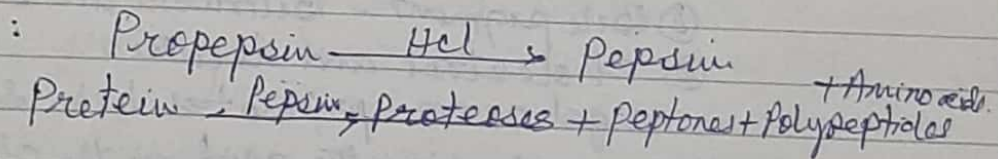
Gastric glands of stomach secrete ^{gastric} juice. The gastric glands ^{are} stimulated to secrete the gastric juice by a hormone gastrin.

The gastric juice is an acidic watery fluid with 0.2-0.5% HCl, a variety of ions like Na^+ , K^+ , Ca^{++} , PO_4^- , SO_4^- and HCO_3^- . Its pH varies from 1-2. The major enzymes are:

(a) Propepsin converted into active enzyme pepsin by HCl secreted by oxyntic cell.

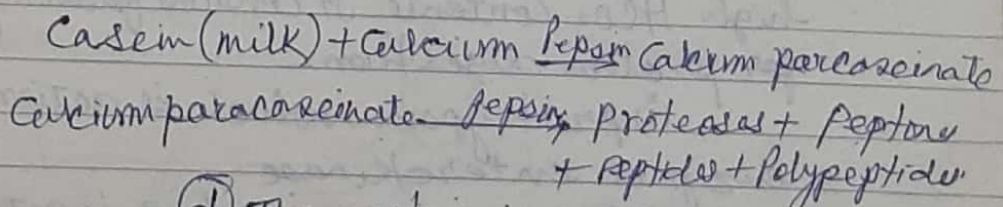
(b) Pepsin converted protein into proteases, peptones, polypeptides and amino acids (a few)

The optimum pH for pepsin is 1.5. The high acidity in stomach alters the ionization of $-\text{COOH}$ and $-\text{NH}_2$ groups in protein thereby changing protein structure.



(c) Renin in presence of Ca^{++} curdles milk and converted protein into calcium paracaseinate.

The pepsin act on calcium paracaseinate and converted it into proteases, peptones and polypeptides.



(d) The gastric juice in carnivorous contains small amount of gelatine which hydrolyse gelatin into proteases and peptones.

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Semidigested food in stomach is called acidic pulp or chyme. As the chyme move forward into duodenum, its mucosal cells of the duodenum secrete three hormones.

- (i) cholecystokinin-pancreozymin (CCK-PZ)
- (ii) Secretin
- (iii) Enterogastrone.

CCK-PZ stimulates the gall bladder to secrete bile. Secretin stimulates the pancreas to secrete pancreatic juice. Enterogastrone stops the further secretion of gastric juice.

Bile: It is watery alkaline fluid greenish yellow fluid. It contains a 2% salt content.

It consists of:

- (a) Bile salts - Sodium bicarbonate, sodium taurocholate and sodium glycocholate.
- (b) Bile pigment - Bilirubin and biliverdin.
- (c) Cholesterol and lecithin.

vagal nerve promotes bile secretion.

NaHCO_3 neutralizes the acid in the chyme and renders the duodenal content alkaline. The other salts emulsify the fats and thereby increase the surface area of the substance for enzyme action.

Pancreatic juice $\xrightarrow{\text{Bile}}$ Emulsified fat

It is colourless alkaline fluid with high HCO_3^- content. It contains following enzymes for protein digestion.

- (i) protrypsin, which is activated by enzymes enterokinase
- (ii) prochymotrypsin which is activated by trypsin into chymotrypsin.

protrypsin $\xrightarrow{\text{Enterokinase}}$ Trypsin
prochymotrypsin $\xrightarrow{\text{Trypsin}}$ Chymotrypsin.

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(iii) Peptidase - mostly carboxypeptidase

In carnivorous two other proteolytic enzymes are found in pancreatic juice in small amount, these are - ~~(a) Elastase~~

(a) Elastase - which hydrolyses elastin into proteosal and peptones etc.

(b) Collagenase - this hydrolyses collagens into polypeptides.

Trypsin acts on protein and proteoses and converts them into polypeptides, oligopeptides and some amino acids.

Chymotrypsin acts on proteoses, peptones and polypeptides and converts them into oligopeptides and some amino acids.

Carboxypeptidase splits the terminal peptide bond on the side of free $-COOH$ group

The optimum pH is 8-9.

Protein $\xrightarrow{\text{Trypsin}}$ protease

Protease $\xrightarrow{\text{Trypsin}}$ polypeptides + oligopeptides + some amino acids

Protease $\xrightarrow{\text{Chymotrypsin}}$ oligopeptides + amino acids

Polypeptide $\xrightarrow{\text{Carboxypeptidase}}$ Dipeptide + Amino acid

DIGESTION OF PROTEIN IN SMALL INTESTINE:

As the food passes beyond duodenum it is in the form of an alkaline pulp called chyle.

Succus entericus or Intestinal juice :-

It is secreted by crypts of Lieberkühn found between base of two villi in the small intestine.

Mucus and water are contributed by the Brunner's gland situated in submucosa of duodenum.

Succus entericus is a thin colourless fluid with a slightly alkaline pH (7.2 to 8).

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Succus entericus includes following proteolytic enzymes — Aminopeptidase, dipeptidase, tripeptidase

All these enzymes finally converted semi-digested proteins into free amino acids in small intestine where finally absorption of protein in the form of monomers or dipeptides takes place.

Proteins + Peptides + Polypeptides $\xrightarrow{\text{Aminopeptidase}}$ Dipeptides + Amino acids

Dipeptides $\xrightarrow{\text{Dipeptidase}}$ Amino acids + Amino acids

Absorption of Protein :-

Proteins are mainly absorbed in the form of amino acids. Rarely proteins are absorbed in the form of peptides. Absorption is an active or passive process. They are absorbed by the blood capillaries of villi and transported by the portal system.