Gastric Juice: Meaning & Constituents | Digestive System | Human | Biology

Article Shared by Rakshitha C

In this article we will discuss about the meaning and important constituents of gastric juice.

Meaning of Gastric Juice:

Gastric juice is a mixture of secretions of the different types of glands found in the stomach. As a whole gastric juice is acid in reaction, but when collected separately, it is found that, the body and fundus secrete an acid juice, while the pyloric part secretes an alkaline juice.

During fasting stomach secretes at a variable rate of 10 – 60 ml per hour. This juice is rich in mucus, poor in acid and contains pepsin. It probably acts as a mild antiseptic against swallowed bacteria. After meal gastric secretion is stimulated.

On the average 500 ml of gastric juice is secreted per meal. The secretion starts almost immediately after food, reaches its maximum between one and a half to two hours, then gradually declines and comes to the fasting level after three to four hours.

Important Constituents of Gastric Juice:

1. Hydrochloric Acid:

This is secreted by the oxyntic cells (parietal cells.) They are present in the fundus and the body of the stomach. There are many theories regarding formation of HCI. The views of Davenport, Davies and others explain the formation of HCI in a simplified way.

According to them, the H^+ and OH ions are formed by ionisation from water or other metabolites. H^+ ions are passed out of the oxyntic cells into the canaliculus of gastric gland. This is an active process, the energy for which is derived from aerobic and anaerobic glycolysis.

The secretion of HCI stops when energy conversion is blocked by DNP, etc. The transport is also dependent on oxidative phosphorylation. For each H^+ ion released, one OH^+ ion is held back in the cell. This OH^+ ion combines with the H^+ ion released from dissociation of H_2CO_3 into HCO^+_3 and H^+, the HCO^+_3 being released in the circulation.

The H_2CO_3 is formed in the cell by the combination of CO_2 and H_2O, the reaction being catalised by the enzyme carbonic anhydrase, present in the gastric cells in large amounts. Since blocking the action of carbonic anhydrase by diamox, the HCI formation stops, so carbonic anhydrase plays an important role in the HCI formation. After meal there is an increase in pH of systemic blood and urine due to liberated HCO^+_3 and is named as alkaline tide.

Secretory Mechanism:

It is an active process and consists of at least four parts:

1. Aerobic and anaerobic reactions produce high-energy phosphate bond (~P) which provides energy for driving the secretory reaction. Compounds such as fluoroacetate which stops TCA cycle and interferes energy formation and DNP which makes ~P unavailable for work (without reducing O_2 consumption) inhibits acid secretion.

2. The secretory reactions proceed in three stages:

(a) One ~P combines with reduced low-energy precursor to produce a reduced high-energy precursor,

(b) This high-energy compound is oxidised yielding H^+, an electron and a low-energy precursor. The energy is utilised in transporting the H^+ against concentration gradient (0.00005 mN in plasma to 150 -170 mN in gastric juice),

(c) The oxidised low-energy precursor is reduced by substrate electrons and is available for reaction 2(a).

3. The electron liberated in reaction 2(b) is accepted by oxygen producing hydroxyl ions.

4. The OH produced are neutralised by acceptance of proton from buffers, produced as (CO_2+ $H_2O \rightarrow H_2CO_3 \rightarrow H^+$+ HCO^-_3) in presence of carbonic anhydrase, which forms water H^++ OH^+ = H_2O). The HCO^-_3 passes to the blood and urine increasing the pH, which is known as alkaline tide.

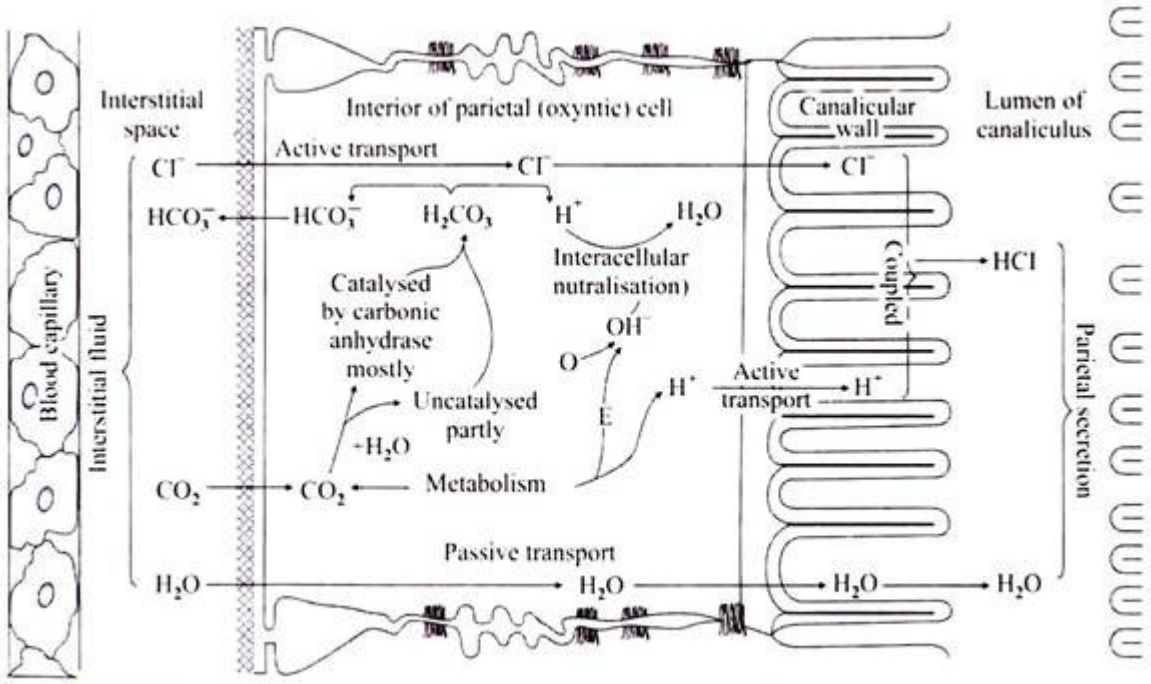

Fig. 9.37 Mechanism of secretion of hydrochloric acid by parietal cell (Diagrammatic representation).

2. Pepsin:

i. Manufactured by peptic cells.

ii. In the resting cells it is present in the form of zymogen granules as pepsinogen. During secretion these granules disappear.

iii. Pepsinogen has been isolated in pure form.

iv. Pepsinogen is converted into active pepsin by any solution having acidity stronger than pH 6.0. Under normal conditions, HCI of gastric juice activates pepsinogen into pepsin. But any other inorganic acid also do it.

v. In the process of activation, about 15% of the nitrogen content of the pepsinogen molecule is lost.

vi. Pepsin is inactive in neutral or alkaline medium, but it is highly proteolytic in strong acid solutions. On the average, the optimum pH lies between 1.5 – 2.0.

vii. The optimum pH varies with the nature of protein to be acted upon. For instance, for albumin and globulin it is about 1.5, for casein 1.8, for gelatin 2.2 and so on.

viii. Pepsin is protein in nature. It acts upon proteins and converts them up to peptone, but not to free amino acids.

ix. Pure crystalline pepsin can also act like rennin and coagulate milk.

x. An enzyme gastricsin having about one-fourth the activity of pepsin is secreted by gastric cells. Optimum pH of this enzyme is 3.0.

xi. Another proteolytic enzyme cathepsin (optimum pH 4.0) has also been found in the gastric juice.

xii. Human blood and urine contain uropepsinogen derived from the stomach. The uropepsin of strongly acid urine has proteolytic property.

3. Rennin:

Rennin is a separate enzyme present in the stomach of calf and other young animals at least, and has milk- coagulating action. It is a thioproteose (sulphur-containing proteose). It has been isolated in pure form. Its optimum pH is 6.0 – 6.5, so that the high gastric acidity (pH 2.0) in adults inactivates this enzyme. Infant's stomach also has a pH which is lower than the optimum pH for rennin activity, and most possibly this enzyme has no functional role in human beings. The clotting and digestion of milk in man is affected by pepsin.

Rennin coagulates caseinogen with the help of Ca ion. The action takes place in two stages. In the first stage rennin converts caseinogen into soluble casein. In the second stage Ca ion combines with soluble casein and forms insoluble Ca caseinate. This is the clot. It is believed that rennin is secreted by the peptic cells.

According to Hollander, it is suggested that there is single enzyme for proteolysis instead of many which may have two or more active centres, each of which attacks a different type of peptide linkage at different pH so possesses its own characteristic pH curve.

4. Gastric Lipase:

It is a weak fat-splitting enzyme, quite distinct from the lipases of pancreatic juice and succus entericus. Gastric lipase is a tributyrase and acts on butter-fat tributyrin. Lipase acts best in a slightly acid medium (optimum pH 4.0 – 5.0) and is destroyed by alkali or high acidity. Hence, this enzyme is not of much importance in adults where the gastric acidity is high. In infants, gastric acidity being low, tributyrase enzyme is important for digestion of their staple food—milk. This also is probably secreted by the peptic cells.

5. Gastric Mucin:

Mucin is secreted chiefly by the cells in the pyloric region and to some extent by the mucous cells and goblet cells in the body and fundus. Visible mucus is secreted by the surface epithelial cells of the gastric mucosa and is thick, viscous and even jelly-like. It forms a transparent coating over the surface of the gastric mucosa.

Soluble or transparent mucus is secreted by the cells of the pyloric and cardiac glands, and also by the mucous neck cells of the fundic glands. It is a constituent of pure gastric juice (dissolved mucin). Mucin is a glycoprotein.

It serves certain important functions:

i. It acts as a buffer and has a high acid-combining power. Thus it reduces high gastric acidity and prevents injury to the gastric mucosa.

ii. To some extent it inhibits peptic activity and this action is due to the presence of mucoitin sulphuric acid in it.

iii. By forming a coating on the mucous membrane it protects the latter from the injurious effects of the gastric juice.

iv. It also acts as a lubricant.

A gastric-secreting inhibition has been isolated from the gastric juice of patients with achlorhydria and pernicious anaemia. The nature of this inhibition is not known, but it was found in the mucin fraction of gastric juice of normal man although the potency is greater in these patients. The exact nature is not known. This secretory inhibitor has also been isolated from human saliva and the name has been given as gastrone. Gastrone can inhibit secretion stimulated by histamine or gastrin. It may have some relation to the neuropoietic factor explained below.

6. Intrinsic Factor:

A heat-labile mucoprotein possibly secreted from neck chief cell is responsible for the proper absorption of vitamin B_{12} (extrinsic factor). Absence of this causes pernicious anaemia. Secretion of this factor takes place before HCl or pepsin.

7. Neuropoietic Factor:

As pernicious anaemia is often associated with subacute degeneration of spinal cord, it has been suggested that the stomach might produce a factor responsible for nutrition of the nervous system.

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