4 Main Phases of Gastric Secretion | Digestive System | Human | Biology

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Gastric secretion has divided into four phases: 1. Nervous Phase 2. Gastric Phase 3. Intestinal Phase 4. Interdigestive Phase.

1. Nervous Phase:

A pouch of Pavlov is prepared in a dog and upon the same animal oesophagus is divided, as done in the experiment of sham feeding. The food, swallowed by the animal, comes out through the cut end of the oesophagus and does not enter stomach. In spite of it, it is found that the stomach secretes after a latent period, of about 5-10 minutes and continues for as long as $1^{1/2}$ hours. When the vagi are cut this secretion fails to occur.

i. Stimulation of the vagus produces a secretion rich in pepsin and HCl also some mucus, the most powerful action is possibly on acid secretion. The gastric cells are stimulated by acetylcholine released after vagal action. There is also a possibility that increased amount of histamine, liberated at the mucosa of stomach after vagal stimulation, stimulates the parietal cells.

Vagal stimulation also causes vasodilatation of the gastric mucosa. Under certain conditions vagal stimulation can also stop or diminish gastric secretions. Stimulation of the vagus also increases the release of gastrin and augments the response of the cells of stomach to other type of stimuli.

ii. Stimulation of the sympathetic nerves, supplying the stomach causes vasoconstriction, but its effects on gastric secretion are not constant.

iii. Hypothalamus exerts undoubted influence upon gastric secretion. Stimulation of hypothalamus increases gastric secretion by augmenting vagal activity. Hypoglycaemia has similar effect mediated in an identical way. Experimental lesions of hypothalamus have been found to produce gastric haemorrhages, erosions and even perforations. It is believed that some such lesion may be associated with the causation of gastric ulcer.

iv. These show that the initial phase of gastric secretion is a reflex process and this type of secretion is called appetite juice by Pavlov.

On further analysis it is seen that two types of reflexes are involved in it:

i. Unconditioned Reflex:

The sensory stimulus for the unconditioned reflex arises in the mouth during chewing and swallowing of the food. The sensory nerves are the fifth, seventh and ninth cranial nerves. The motor nerve is the vagus.

ii. Conditioned Reflex (Psychic Reflex):

The existence of conditioned reflex is proved by the fact that sight or smell of the accustomed food stimulates gastric secretion. Various other conditioned stimuli can be established which can arouse gastric secretion even when no food is actually given to the dog, i.e., without the contact of food in the mouth. The sensory nerves are those of special senses, viz., vision, smell and hearing. Motor nerve is the vagus.

The Appetite Juice:

It has got the following characters:

i. It is rich in pepsin, acid in reaction and contains mucus.

ii. The composition of appetite juice is constant and does not vary with the type of food.

iii. The quantity varies with the intensity of appetite.

iv. The secretion of psychic juice may be inhibited by shock, fear, anxiety, etc.

v. In animals it forms a considerable part of the total gastric secretion but in man the quantity is probably much less and is not essential.

vi. Its importance lies in the fact that it helps to initiate the second phase of gastric secretion.

2. Gastric Phase (Hormonal):

At the end of sham feeding, gastric secretion elicited by cephalic phase dies away. But if food enters the stomach, further secretion of gastric juice takes place. The gastric phase of secretion is mediated by local and vagal reflex response to distention and also by the hormone gastrin released by the mucosa of the pyloric area.

Thus when the stomach is completely denervated, this secretion is not affected. This proves that this secretion is addition to a nervous reflex and mechanical irritation of food on the gastric mucosa is due to a chemical stimulus. By further experiments it has been proved that a chemical excitant is actually operating in this phase and is called gastrin (Fig. 9.33).

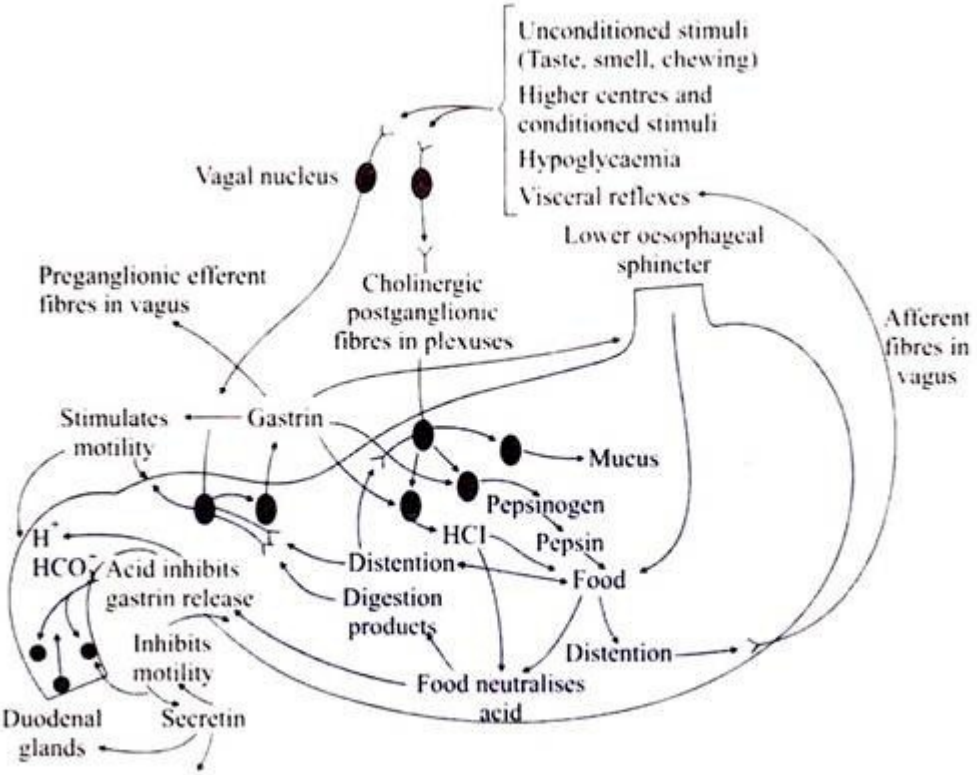

Fig. 9.33 Action of hormones controlling gastric secretion (Schematic representation). From *physiology of the Digestive Tract,* by Horace W. Davenport, Year Book Medical Publishers, Inc. Used by permission.

The following experimental facts can be put forth to uphold the gastrin theory:

i. Acid extract of pyloric mucosa, on injection, stimulates gastric secretion.

ii. At the height of gastric secretion, a substance is found to be present in the venous blood of stomach which can excite gastric secretion.

iii. Ivy and Farrell cut out a small pouch from the body of the stomach and grafted it in the mammary region of a pig. The mammary gland being highly vascular, the graft easily sets there. The wound in the stomach is adequately sutured. With such a preparation it is seen that, when the second phase of gastric secretion, is taking place in the main stomach, the grafted pouch also secretes gastric juice.

Since there is no nervous connection between the stomach and the grafted pouch and there is no separate nervous connection (vagus motor) of the pouch, secretion in the latter must be due to a chemical excitant which is carried to the pouch through blood stream.

iv. Komarov has isolated a protein derivative from the pyloric mucosa possessing strong stimulating effect on gastric secretion.

v. After resection of the pyloric part of stomach this phase of gastric secretion is greatly reduced.

vi. When coagulated egg albumin, raw meat, undigested starch or fat, is introduced into the stomach through the gastric fistula or through the oesophagotomy wound of a sleeping dog (to avoid secretion of psychic juice) no secretion takes place.

This proves that these substances neither have any mechanical effect nor carry the necessary chemical stimulus. But when meat extracts, liver extracts and partly digested meat, egg-white, etc., be introduced in the stomach, gastric secretion is stimulated. It has been demonstrated that stimulation of the vagus causes release of gastrin. This gastro-intestinal hormone is also liberated through a local reflex mechanism mediated through cholinergic nerves other than the vagus.

From these observations it can be concluded that gastrin is manufactured by the pyloric mucosa from some products of protein digestion. This substance enters the blood stream, brought back to the gastric glands and stimulates their secretion.

Nature and Action of Gastrin:

It is polypeptide in nature, two gastrins, gastrin I and II, differing in amino acid sequence have been isolated. Both of them stimulate gastric secretion.

On injection:

(a) Gastrin stimulates gastric secretion—which is rich in acid but poor in pepsin,

(b) it stimulates bile secretion, and

(c) It also stimulates pancreatic secretion to a slight extent.

The gastric phase of secretion constitutes the main part of gastric juice and continues for about three hours. Unlike psychic juice, this part of secretion and varies in quality and quantity according to the type of foodstuff.

The variations are as follows:

Response to Food:

i. Meat increases both the quantity and the HCl content.

ii. Bread stimulates a secretion having the greatest digestive power.

iii. Fat inhibits secretion both in quality and quantity. [It also inhibits the movements of stomach] This depressing effect may be due to a chemical substance called enterogastrone. [see below.] The inhibitory effects of fats are more strongly exerted from the duodenum than from the stomach.

iv. Water, tea, coffee, spices, condiments, vegetable juices, etc., stimulate gastric secretion.

v. Mechanical distention of stomach by gas, such as with aerated waters, stimulates gastric secretion (and movements).

3. Intestinal Phase:

It was observed that the presence of certain food substance in the small intestine excites gastric secretion. The latent period is 2 – 3 hours but continues for 8 -10 hours. When water, meat extract, peptone and partly digested proteins etc., enter the duodenum in the process of digestion or are directly introduced into the duodenum (through a duodenal fistula), this secretion occurs.

When these parts are completely denervated this phase of gastric secretion is not affected. This proves that it is due to a chemical stimulant, a hormone or secretagogue absorbed with the food from the intestine, the exact nature of the stimulus is not known.

Gastric secretion can also be inhibited by the presence of certain substances in the duodenum.

For instance:

(a) Introduction of alkali directly into duodenum inhibits gastric secretion, and

(b) Presence of fats in the duodenum inhibits gastric secretion (both the gastric and intestinal phases).

This inhibitory action of fat is due to the liberation of an intestinal hormone called enterogastrone. It inhibits gastric secretion and gastric motility. Such an inhibitory agent has been detected in the blood of fat-fed animals and has been extracted from the intestinal mucosa.

Urogastrone is another inhibitory substance similar to, but not identical with enterogastrone. It has been isolated both from the urine of a normal male and from that of a pregnant women. It exerts a specific inhibitory effect on gastric secretion (for this reason its therapeutic use in the treatment of gastric ulcer has been recommended). Its role in the normal process of gastric secretion is not known.

4. Interdigestive Phase:

Hydrochloric acid secretion has been found to take place at regular intervals, even in fasted man and dog. They all act by stimulating the nucleus of the vagus.

It has been observed that both hormonal and nervous mechanisms are involved in such secretion, the latter being mediated through the vagus. Recently, it is believed that the interdigestive phase is a part of intestinal phase and partly due to spontaneous secretion of saliva.

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