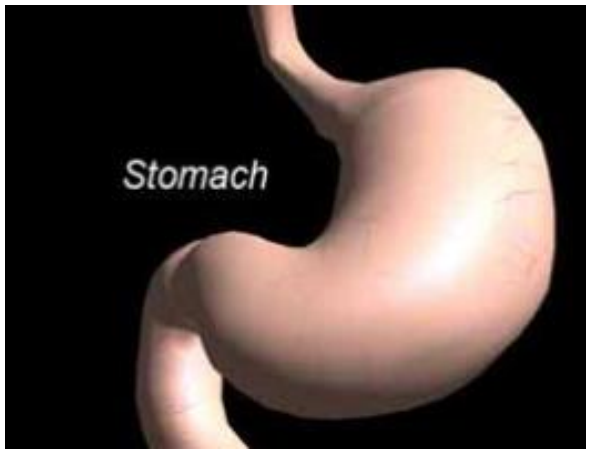
Ashur University
College of Medicine

Grade 2
PHYSIOLOGY OF
GASTROINTESTINAL TRACT
(GIT)
Lec. 6

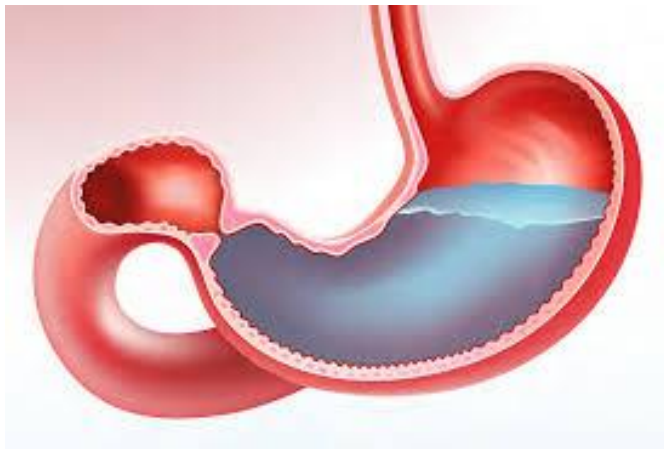
Gastric juice & Stomach Secretions



Ass. Professor Internal Medicine

Dr.Qasim Razzaq Radhi

2/2/2025



Objectives:

- Outline the HCL secretion.
- Describe the functions of HCL.
- Explain the mucus secretion, pepsin, prostaglandins.
- Describe the regulation of gastric secretion.
- Explain the role of Histamine in acid secretion.

COMPOSITION OF GASTRIC JUICE

Gastric secretion about **2-3 L/day . PH about 0.9-1.0**

Gastric juice is a variable mixture of water, Hydrochloric acid , Inorganic (electrolytes) and organic substances.

Inorganic (Electrolytes) : sodium, potassium, calcium, phosphate, sulfate, and bicarbonate.

Organic substances : mucus, pepsins, and protein.

Gastric secretion:

- **HCL**
- **Mucus**
- **Pepsins**
- **Lipase**
- **Gelatinase**
- **Intrinsic factor**

Cations: Na^+, K^+, Mg^{2+}, H^+

Anions: Cl^-, HPO_4^{2-}, SO_4^{2-}

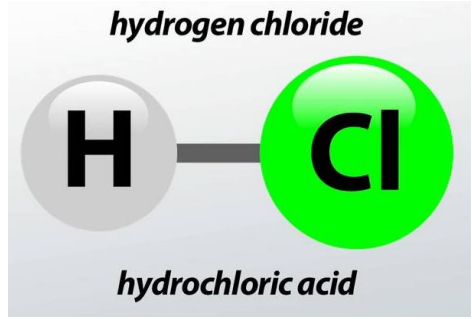
Pepsins

Lipase

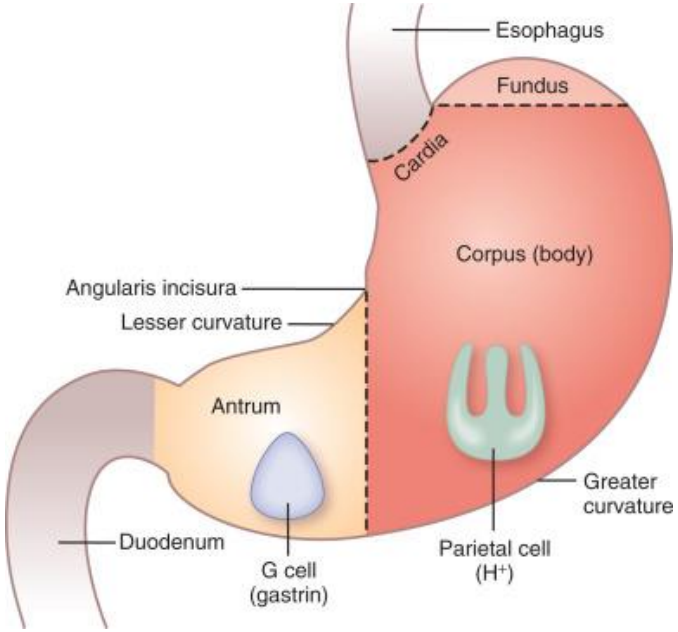
Mucus

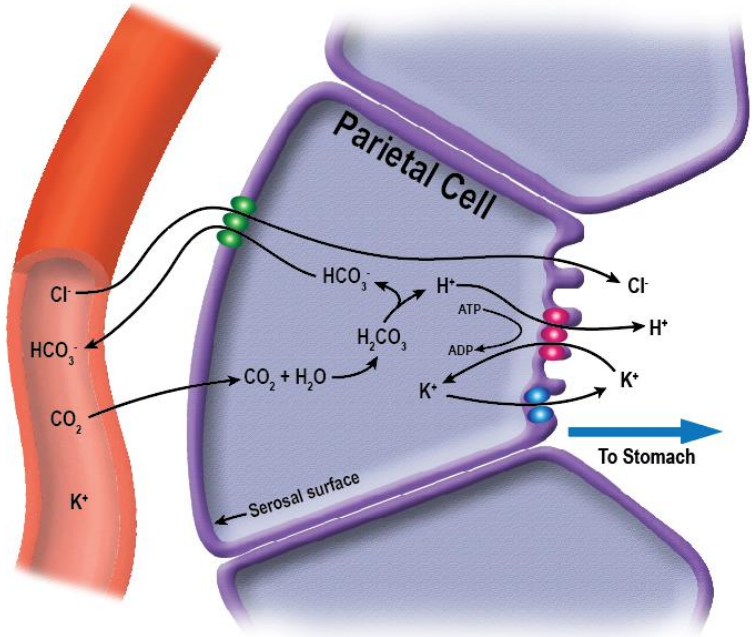
Intrinsic factor

HYDROCHLORIC ACID SECRETION

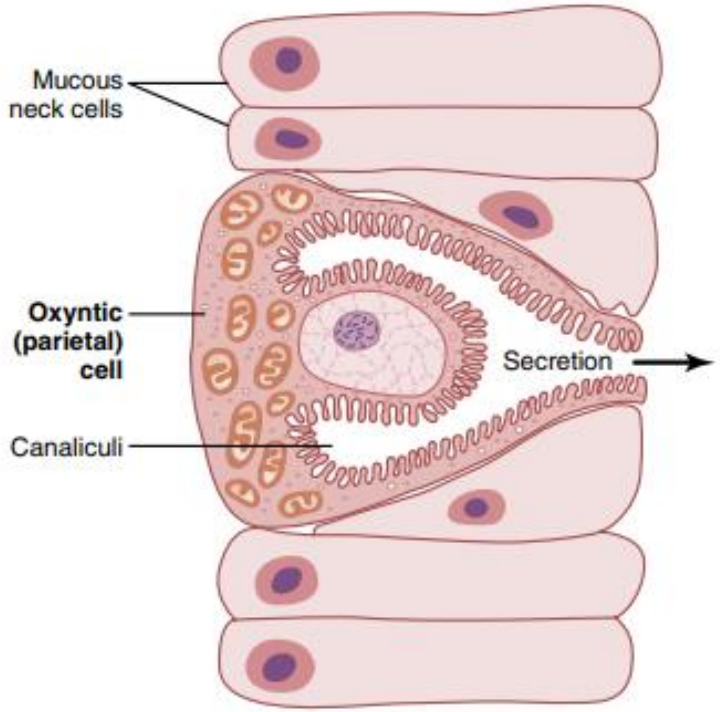


- **When stimulated, the parietal cells (oxyntic cell) secrete acidic solution that contains hydrochloric acid (HCL)**
- The pH of this acid is about 0.8, demonstrating its extreme acidity. At this pH, the H+ concentration is about 3 million times that of the arterial blood.

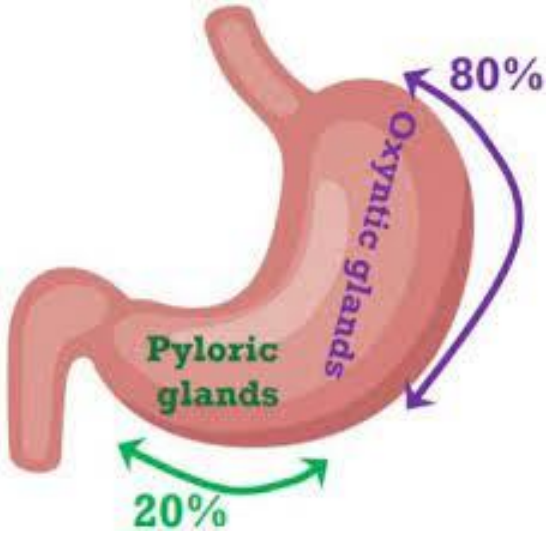


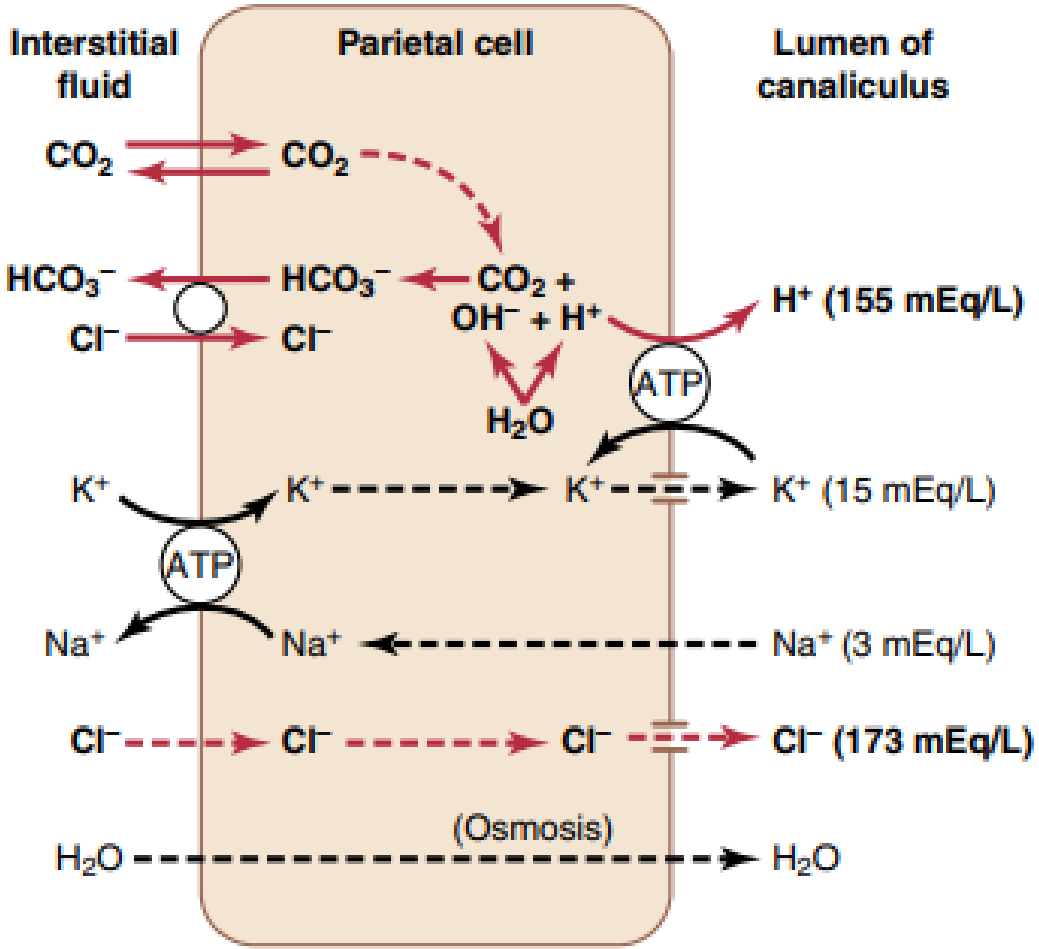


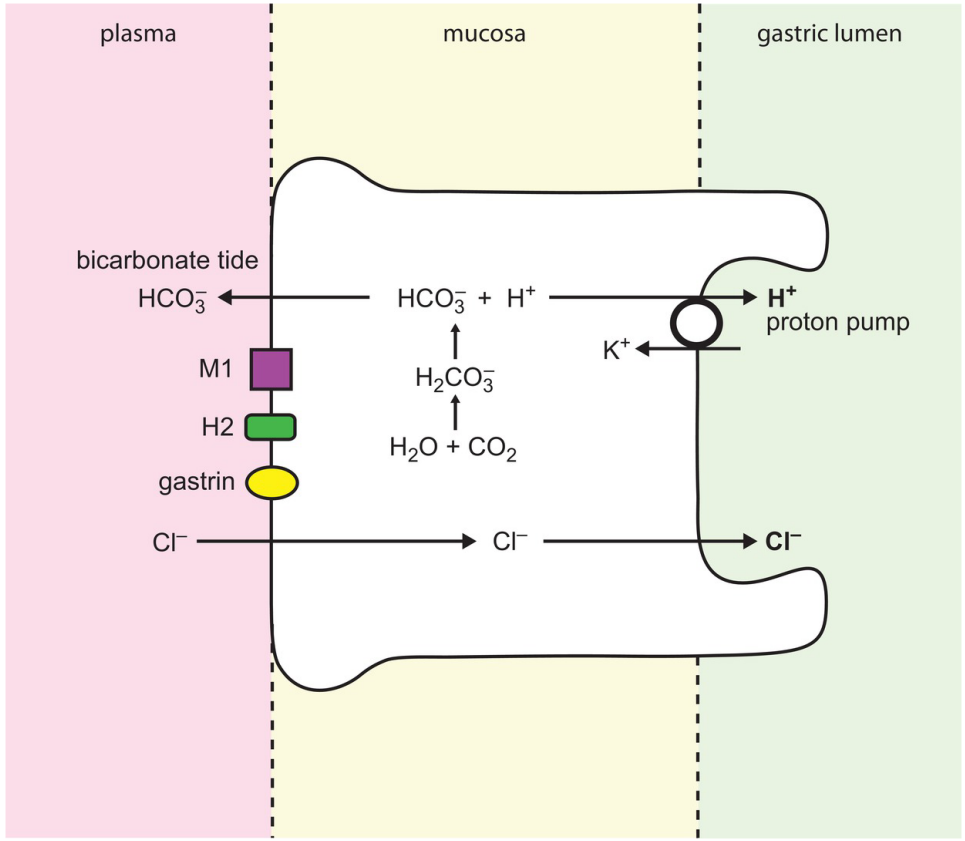
- **Parietal cell (also called an oxyntic cell),** contains large branching intracellular canaliculi. The hydrochloric acid is formed at the villus like projections inside these canaliculi and is then conducted through the canaliculi to the secretory end of the cell , and into the lumen of the stomach.
- The final secretion from the canaliculus contains water, hydrochloric acid, potassium chloride, and a small amount of sodium chloride.



- The **pyloric gland** is found in the pyloric region, the remaining **20 per cent of the stomach**. The pyloric gland **secretes gastrin from its G cells**.







Figure：**Postulated mechanism for secretion of hydrochloric acid. (The points labeled "ATP" [adenosine triphosphate] indicate active pumps, and the dashed lines represent free diffusion and osmosis.)**

Parietal cells (Oxyntic cell)

generate protons (H^+) through carbonic acid (H_2CO_3) synthesis and dissociation into H^+ and HCO_3^-. **HCL secretion :**

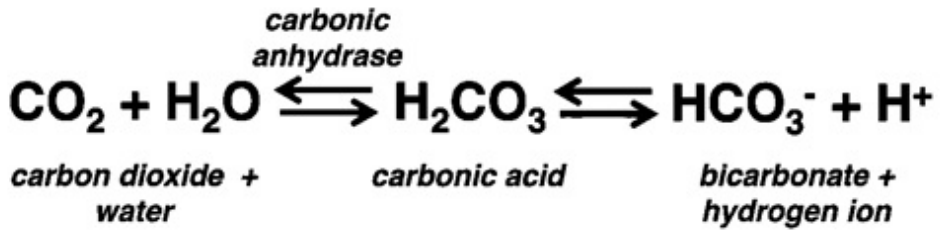
1- Carbonic anhydrase help in formation of **H_2CO_3** from CO_2 and H_2O.

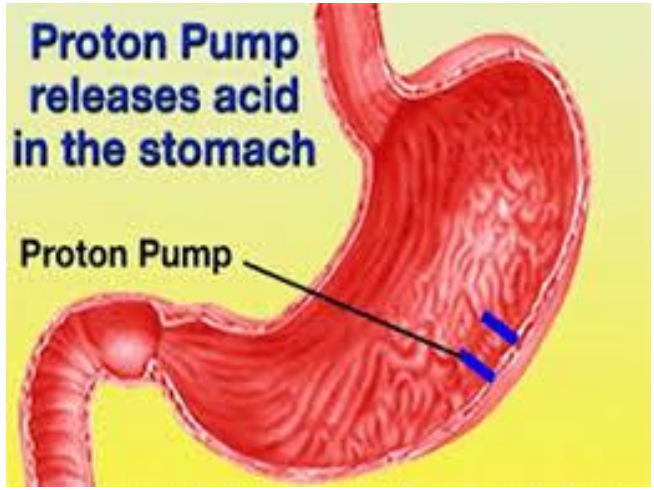
2- H_2CO_3 dissociates to **form H^+** and HCO_3^- in the parietal cell .

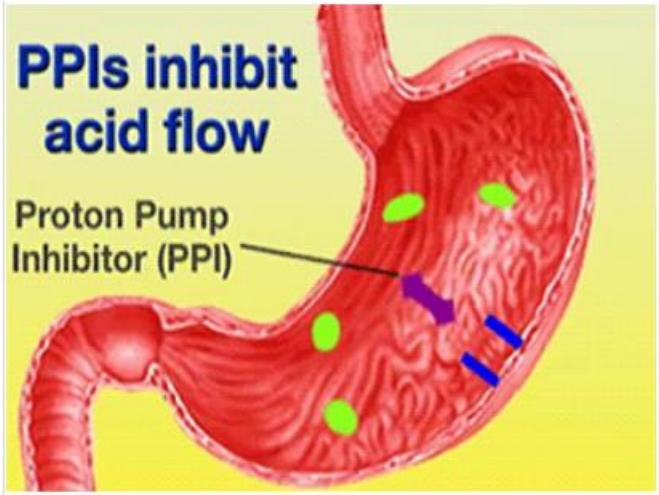
3- H^+ is secreted into the lumen canaliculi of parietal cell in exchange for K+ **by** :

H+-K+ ATPase pump (Proton Pump)

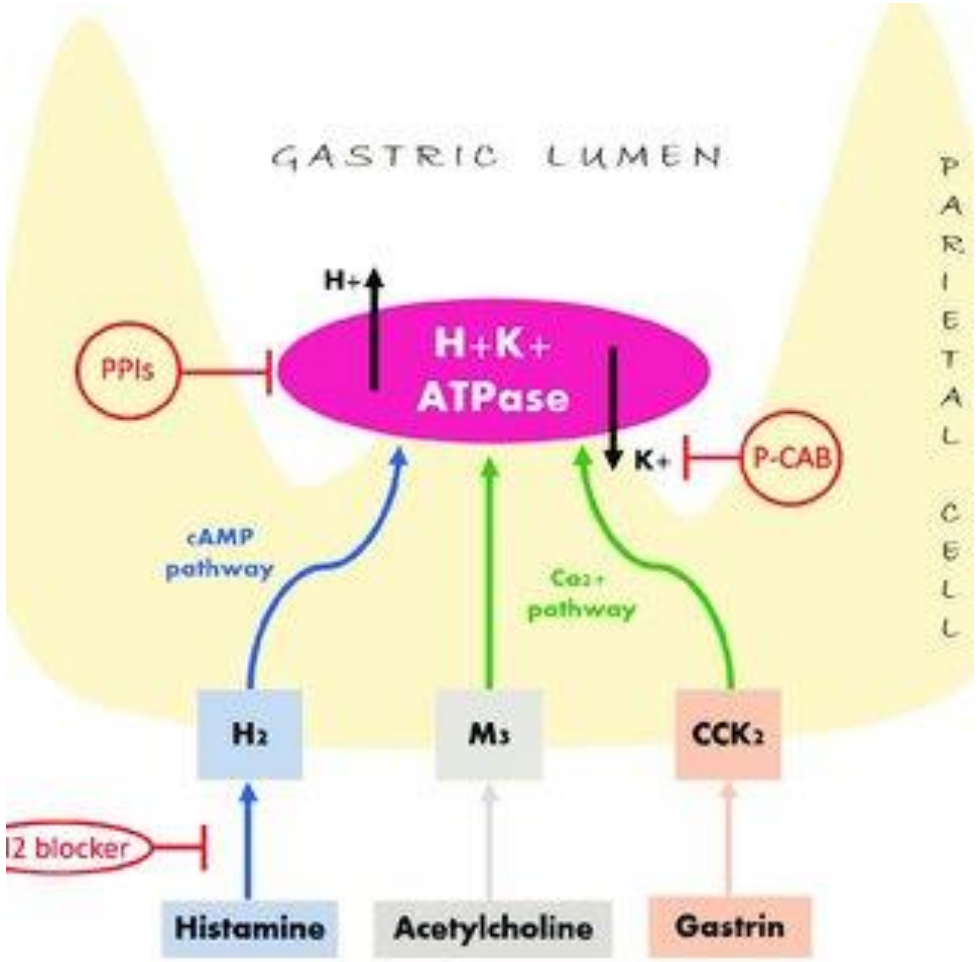
4 - HCO_3^- produced are transported out through antiport in exchange with Cl− at basolateral membrane.







- **The main driving force for HCL secretion by the parietal cells is a hydrogen-potassium pump** (H+-K+ adenosine triphosphatase [ATPase]).
- **Proton pump inhibitors (PPI)** : **inhibit H+-K+ ATPase** e.g : Omeprazole , Esomprazole , Raberazole ,etc ..**used for treatment of peptic ulcers.**

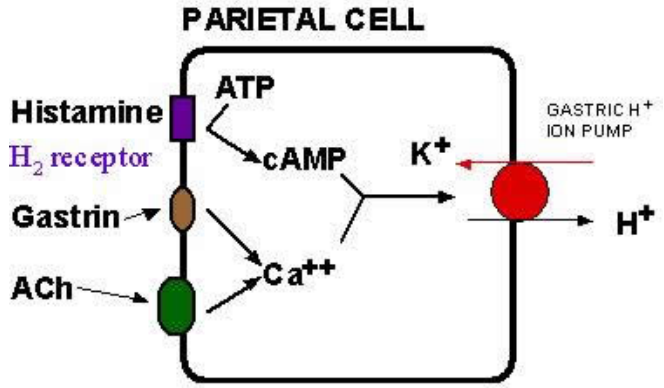


The 3 basic factors that stimulate gastric secretion are (agonists of the parietal cell)

1- Acetylcholine

2- Gastrin

3- Histamine



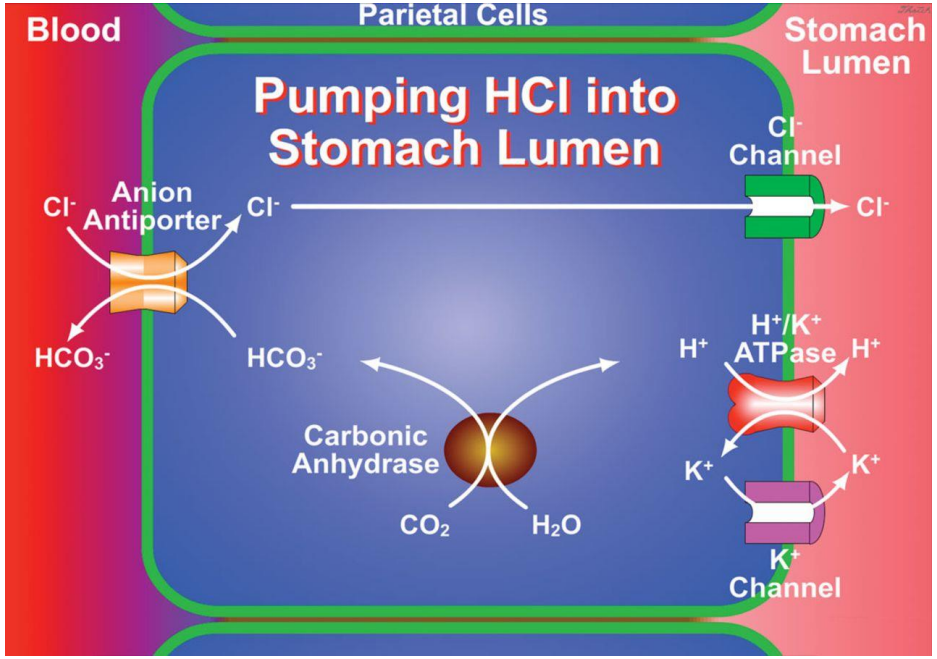




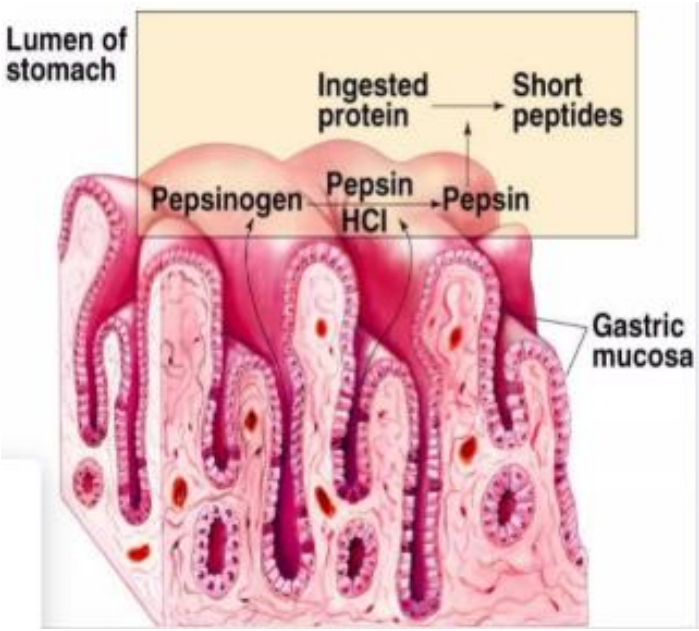
Other suggested mechanism for the formation of HCL

Water inside the parietal cell becomes dissociated into **H+** and hydroxide (OH−) in the cell cytoplasm.

The HCO3 − is transported across the basolateral membrane into the extracellular fluid in exchange for **Cl− ions, which enter the cell and are secreted through chloride channels into the canaliculus**, giving a strong solution of **hydrochloric acid** in the canaliculus.



FUNCTIONS OF HYDROCHLORIC ACID



1- Activate pepsinogen to pepsin : when pepsinogen is first secreted, it has no digestive activity. As soon as it comes in contact with hydrochloric acid, it is activated to form active pepsin. Pepsin functions as an active proteolytic enzyme in a highly acidic medium (optimum pH, 1.8–3.5), but above a pH of about 5 it has almost no proteolytic activity.



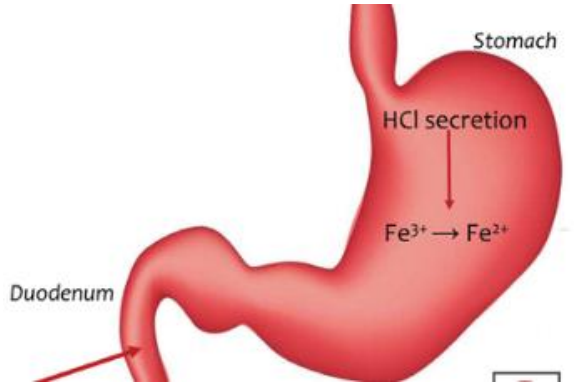
2- Anti-bacterial action : The acid secreted by parietal cells serves to sterilize the meal and kills most microorganisms ingested with food.

3- HCL help absorption of iron

by reducing ferric iron (Fe+3) in the

food to ferrous (Fe+2) state.

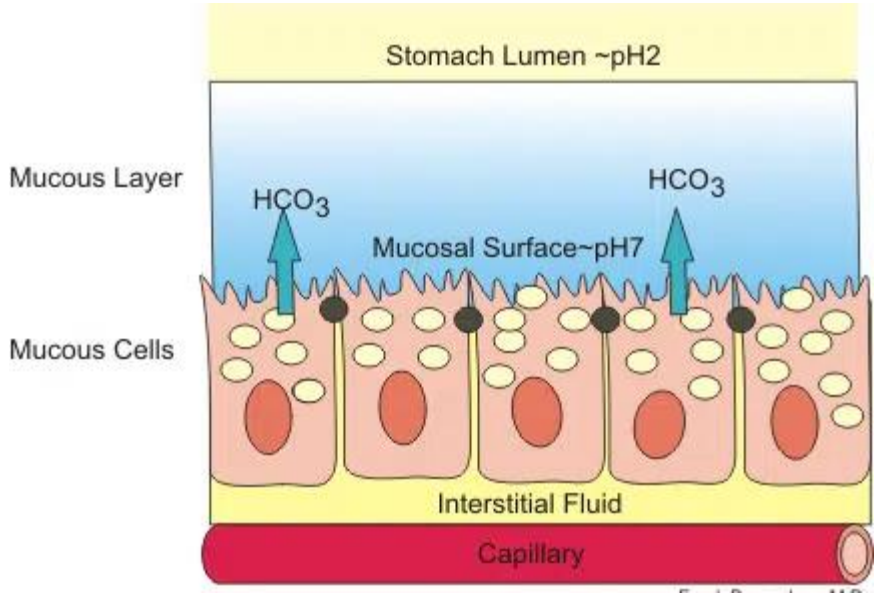




MUCUS SECRETION BY THE STOMACH

Two types of gastric mucus are secreted by the stomach:

1- Soluble mucus : this is secreted by the cells of the pyloric and cardiac gland and also by mucus neck cells of the main gastric gland. **Thin mucus** which is soluble and helps in **protecting the stomach wall from damage by peptic digestion.**



2- Visible mucus : this is secreted by the surface epithelial cells of the gastric mucosa and its more alkaline, **thick, viscid** and even **jelly-like**. It **forms a thick coat (2-3 mm thick)** that covers the surface of the gastric mucosa. The mucus secretion from the surface epithelium is stimulated by various chemical and tactile stimuli. Mucus secreted by neck cells and surface mucus cells in the body and fundus of the stomach and similar cells form a **FLEXIBLE GEL that coats the mucosa**.

The surface mucosal cells also secrete $HCO3^-$

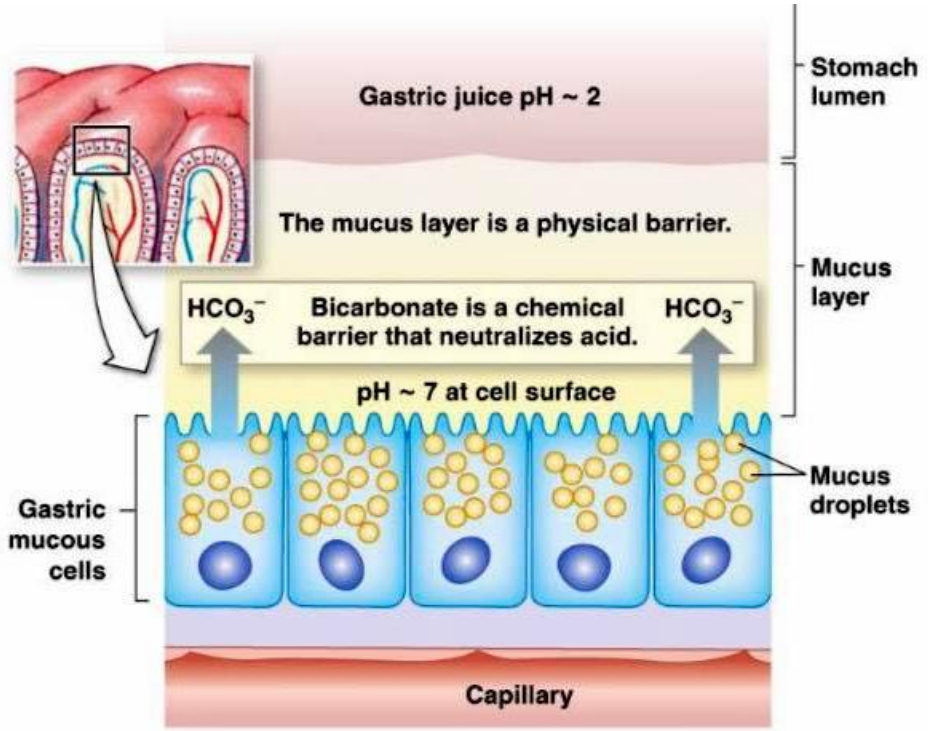
The $HCO3^-$ (Bicarbonate) and the mucus form an **UNSTIRRED LAYER (water layer)** that has a PH around 7.

MUCOSAL BICARBONATE BARRIER that protects the mucosal surface from damage by gastric acid constitute the following :

1- The unstirred layer.

2- The surface membrane of the mucosal cells.

3- The tight junctions between mucosal cells.



PROSTAGLANDINS

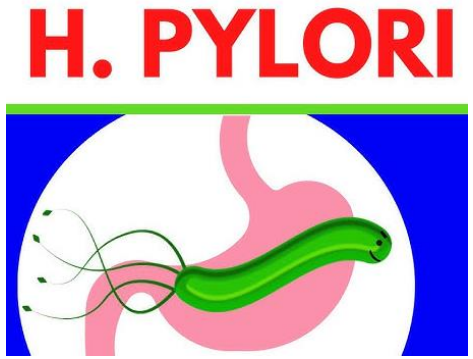
Act as cyto-protector to gastric mucosa by:

1. Stimulate mucus production.
2. Increase bicarbonate secretion.
3. Inhibit acid accumulation.
4. **Increase mucosal blood flow.**

Substances that tend to disrupt the barrier (mucosal bicarbonate barrier) and cause irritation include:

– H.pylori (Helicobacter pylori)
– Aspirin
– NSAID'S (non-steroidal anti inflammatory drugs)
– Ethanol
– Vinegar
– Bile salts

NSAID'S inhibit prostaglandin.

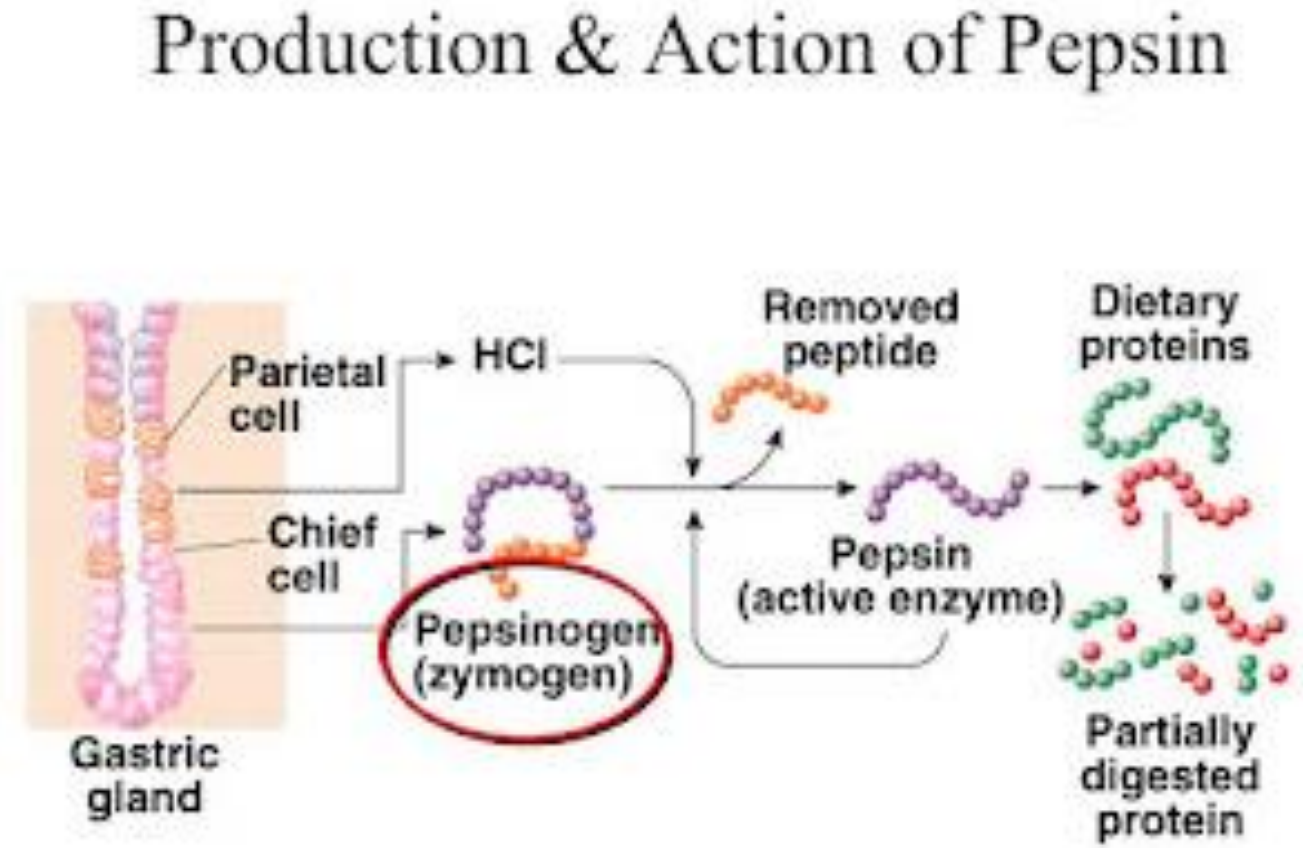






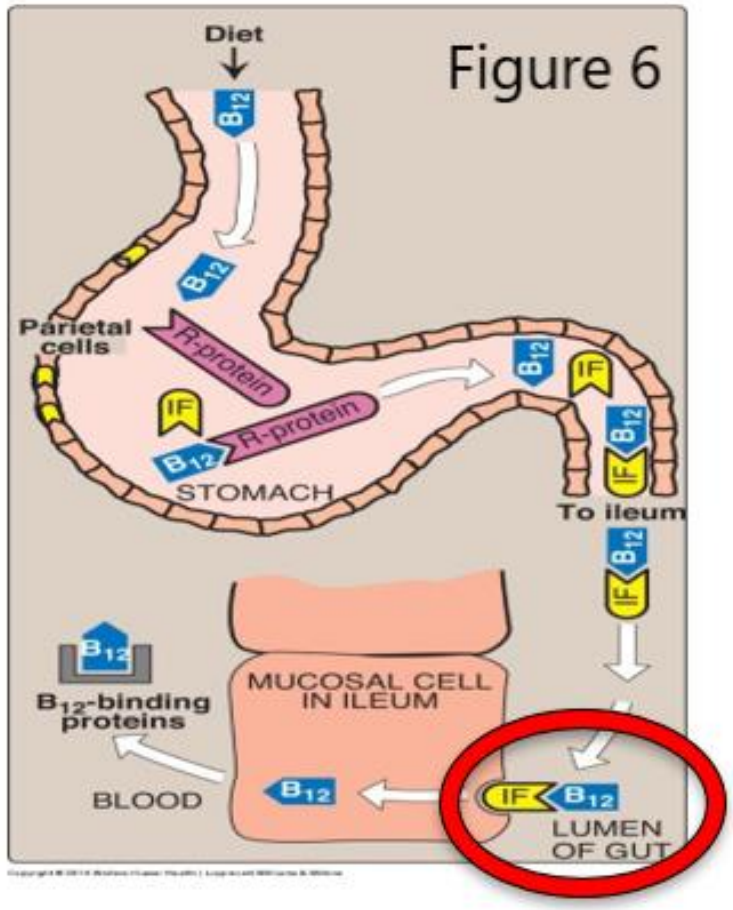
PEPSIN:

- Persin is secreted as pepsinogen and activated by HCL.
- Optimum PH for pepsin is 2 , at PH 5 it will be blocked.



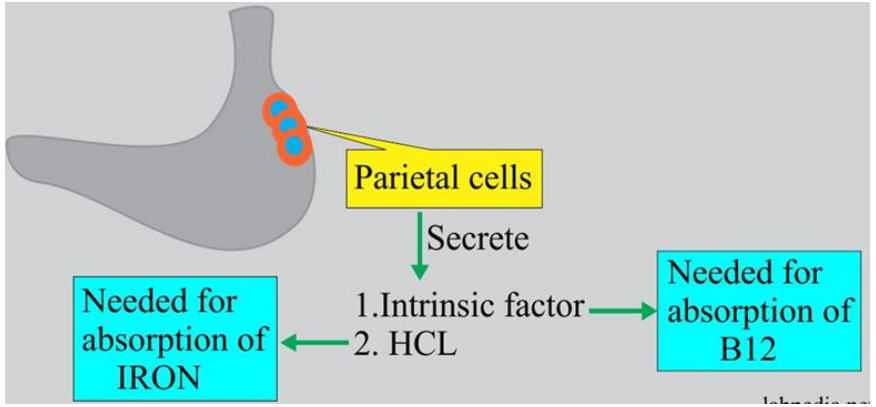
- **Gastric lipase:** weak lipolytic enzyme acts mainly on butter fat.
- **Gelatinase:** liquefies the protein gelatin.
- **Intrinsic factor:** **secreted by the parietal cells**, it is a glycoprotein that combines firmly with vitamin B12→protect vitamin B12 from digestion and also this complex will become bound to specific receptors in the ileum and from there **vitamin B12 (cobalamin)**, **is absorbed** by endocytosis.

  If the acid producing cells of the stomach are destroyed such as after chronic gastritis then the person will develop **achlorhydia**.



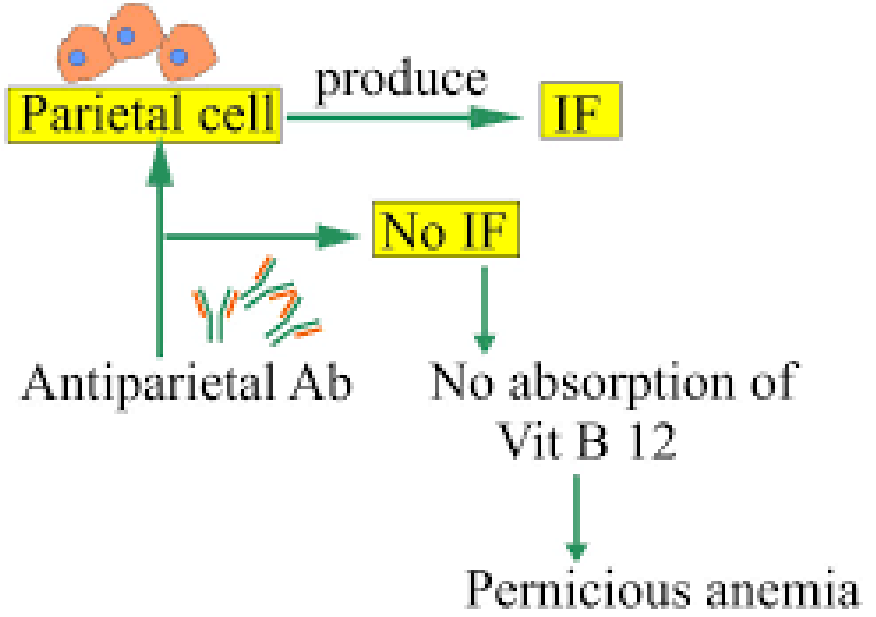
Achlorhydria may be associated with vitamin B-12 deficiency in the setting of pernicious anemia.

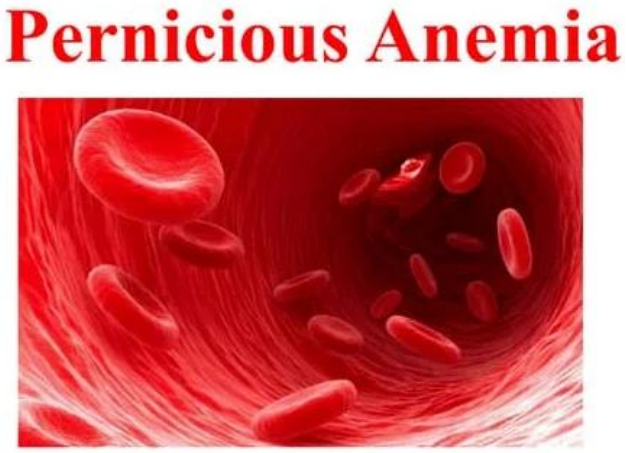
Pernicious anaemia due to the failure of maturation of RBC in the absence of Vitamin B12 stimulation of the bone marrow.



Achlorhydria production **HCL** in the stomach is **absent**

Hypochlorhydria production **HCL** in the stomach is **reduced**.





REGULATION OF GASTRIC SECRETION

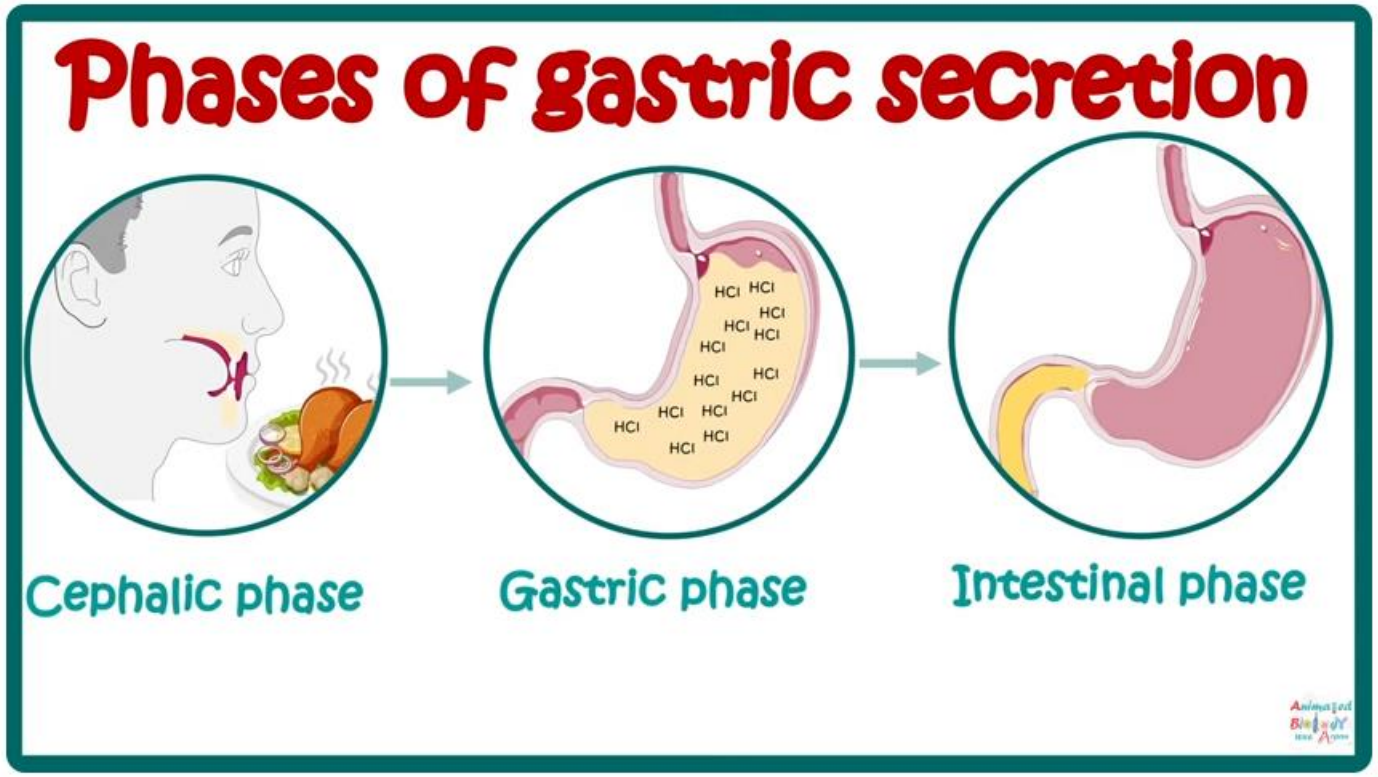
The regulation of the gastric secretion is by both **nervous** and **hormonal** mechanisms.

Gastric secretion associated with a meal can be divided into **3 phases**:-

1.Cephalic phase

2.Gastric phase.

3.Intestinal phase.



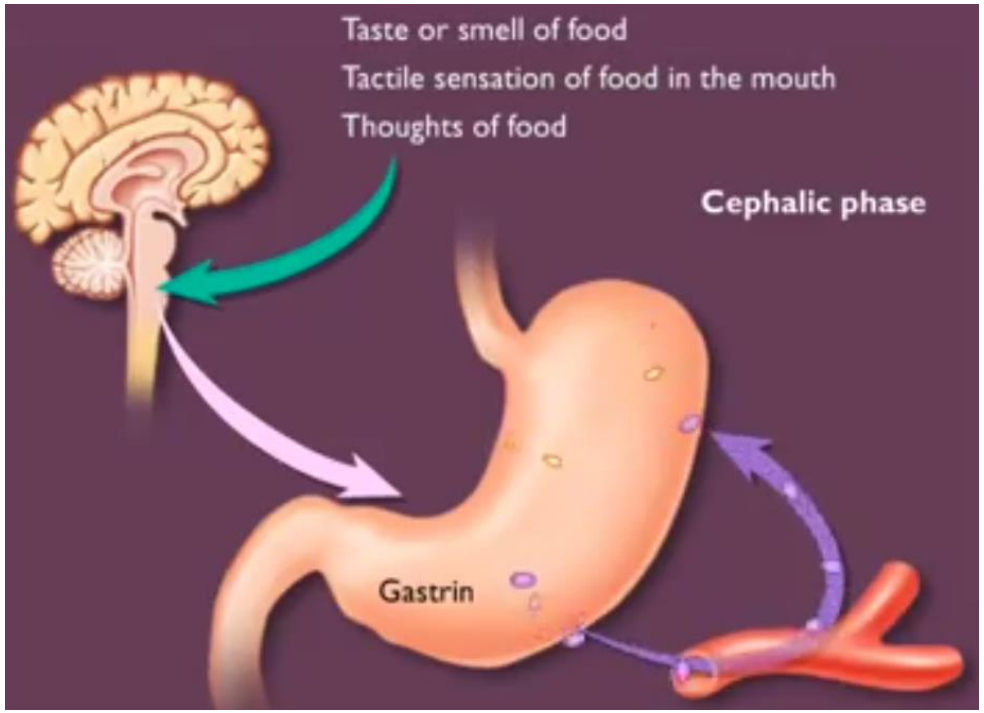
1- Cephalic phase:

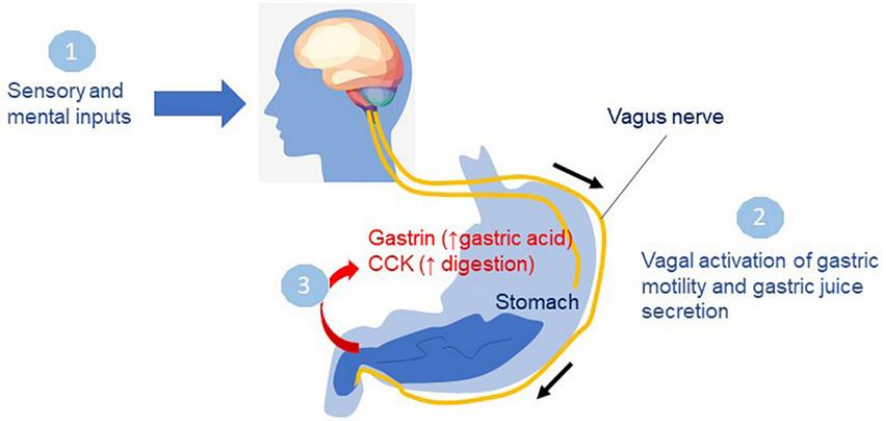
also called nervous or appetite phase.

Gastric secretion can occur even before the food reaches the stomach and it is **controlled by the vagus nerve**. It can be divided into to

2 types:

A-Unconditioned reflex: the secretion results from the taste of the food. The presence of **food in the mouth** will stimulate gastric secretion after five minutes and the secretion may persist for half to two hours. The sham feeding technique by Pavlov proves the mechanism of production of appetite juice.



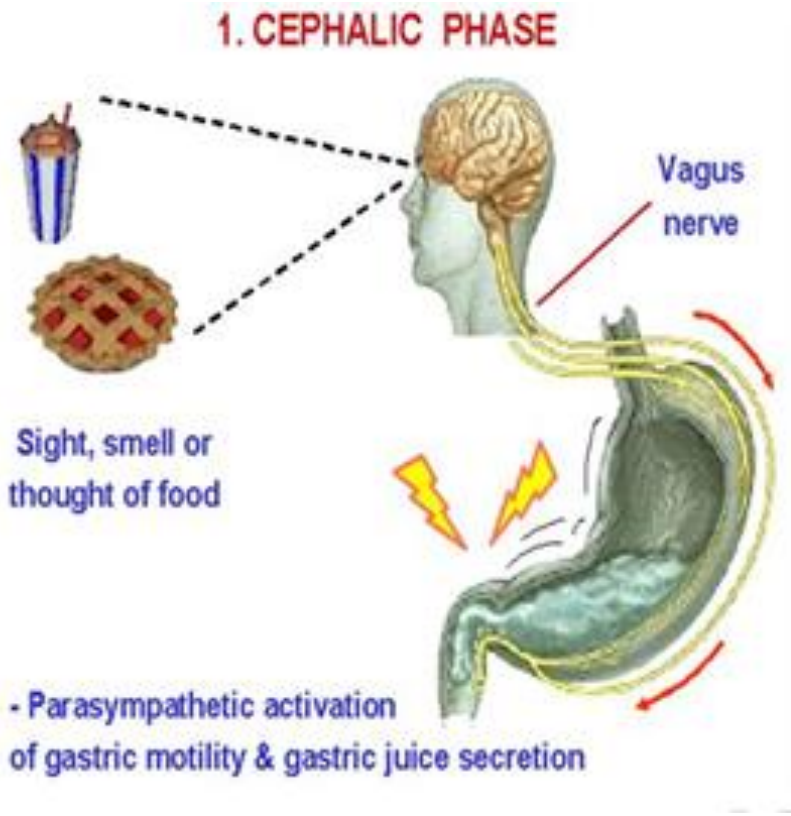


B- Conditioned reflex:

the cephalic phase of gastric secretion can be brought about not only by the **taste of the food** but also **by the sight, smell or thought of food** that's to say by conditioned reflex. The neural pathway for the cephalic phase is **through the vagus** and **can be abolished by: Atropine** ,**Vagatomy** (cutting the vagi).

Gastric secretion in response to this vagal stimulation is highly acidic and high in pepsin.

Cephalic phase accounts for 1/3 to ½ of total gastric acid secretion associated with a meal.



2 - Gastric phase:

presence of food in the stomach stimulates gastric secretion by both:

A-Nervous.

B-Hormonal.

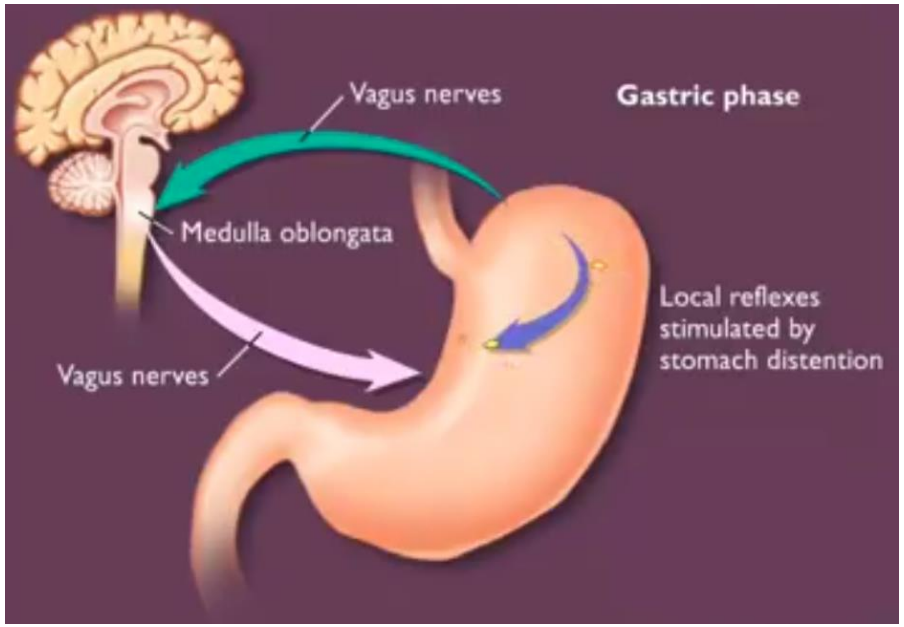
A-Nervous:

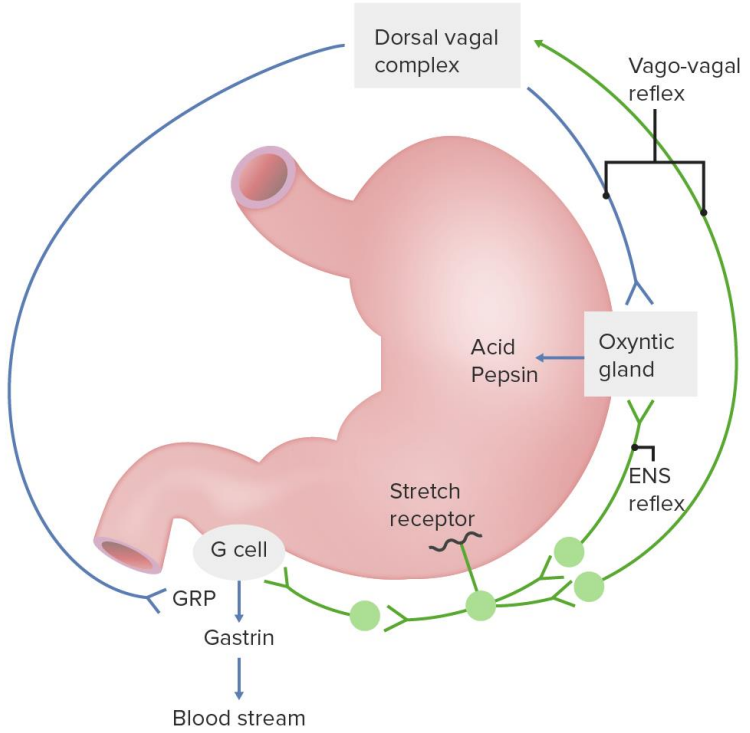
1-Local reflexes in the intrinsic nerve plexus of the stomach (chemoreceptor and stretch).

2-Vagovagal reflexes that passes from the stomach to the brainstem and back to the stomach.

B-Hormonal: → Gastrin .

Gastrin is produced by G-cells in the antrum.





The presence of food in the stomach causes the **release of gastrin** by:

1-Distention → the bulk of food distends the pyloric antrum and this causes the release of gastrin.

2-Certain substances such as peptides and amino acids (meat extract-partially digested proteins).

3-In response to vagal stimulation which release gastrin-releasing peptide (GRP) or Bombesin to produce gastrin.

Gastrin stimulates gastric juice highly acidic but it does not contain high peptic activity.

The gastric phase of secretion accounts for ½ -2/3 (≈ 70 %) of total gastric acid secretion associated with a meal.

ROLE OF HISTAMINE IN ACID SECRETION

Histamine is a powerful stimulant of acid secretion.

There are 3 receptors for histamine **H1 – H2 – H3**

H2-receptors mediate the stimulatory effect of histamine on acid secretion. So

H2-receptors antagonist such as cimitidine – ranitidine – **famotidine**, etc.. are very useful drugs in the treatment of peptic ulcer.



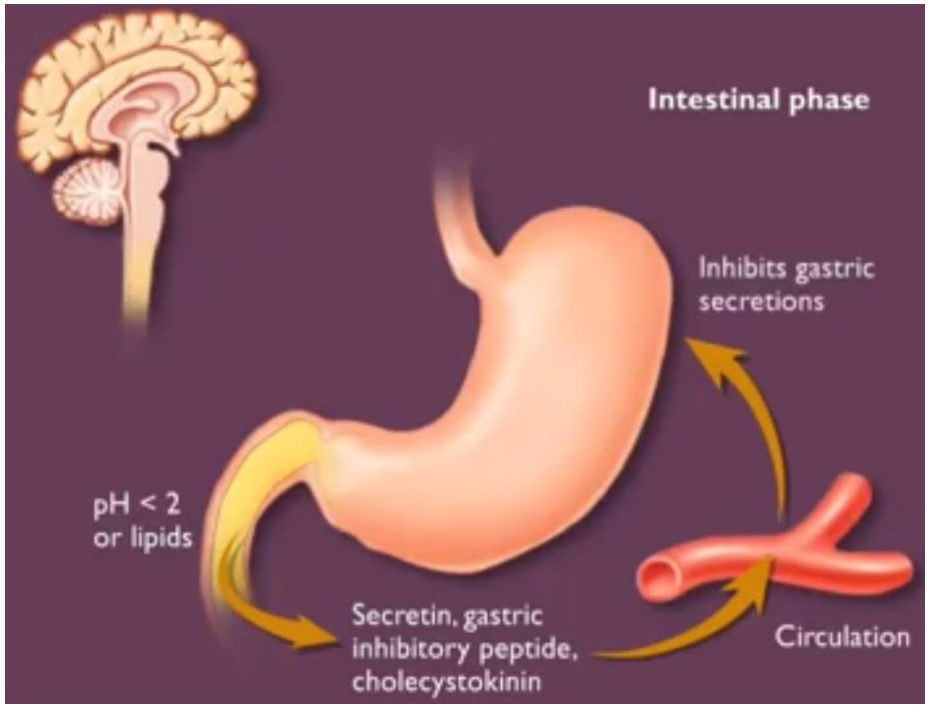
Histamine facilitate the action of gastrin and acetylcholine. It is believed that the stimulatory effect of gastrin on acid secretion is mediated by the release of histamine which in turn stimulates the oxyntic cells to produce acid secretion.

Feedback inhibition of gastric acid secretion by antral factors:

If the PH in the antrum falls to 1.5 or 2 (highly acidic) then there will be inhibition of the gastrin mechanism and thus there will be inhibition of acid secretion induced by gastrin. This will protect the stomach against very high acid secretion. When the PH rises gastrin will be secreted again.

3- Intestinal Phase :

The presence of food in the upper portion of the small intestine, particularly in the duodenum, will continue to cause stomach secretion of small amounts of gastric juice, probably partly because of small amounts of gastrin released by the duodenal mucosa. **This secretion accounts for about 10% of the acid response to a meal.**



Inhibition of gastric secretion by intestinal factors:

Gastric secretion can be inhibited by upper intestinal factors:

1- Acid

2- Fat

3- Protein breakdown products, hyperosmotic or hypo-osmotic fluids.

4- Any irritating factor in the upper small intestine.

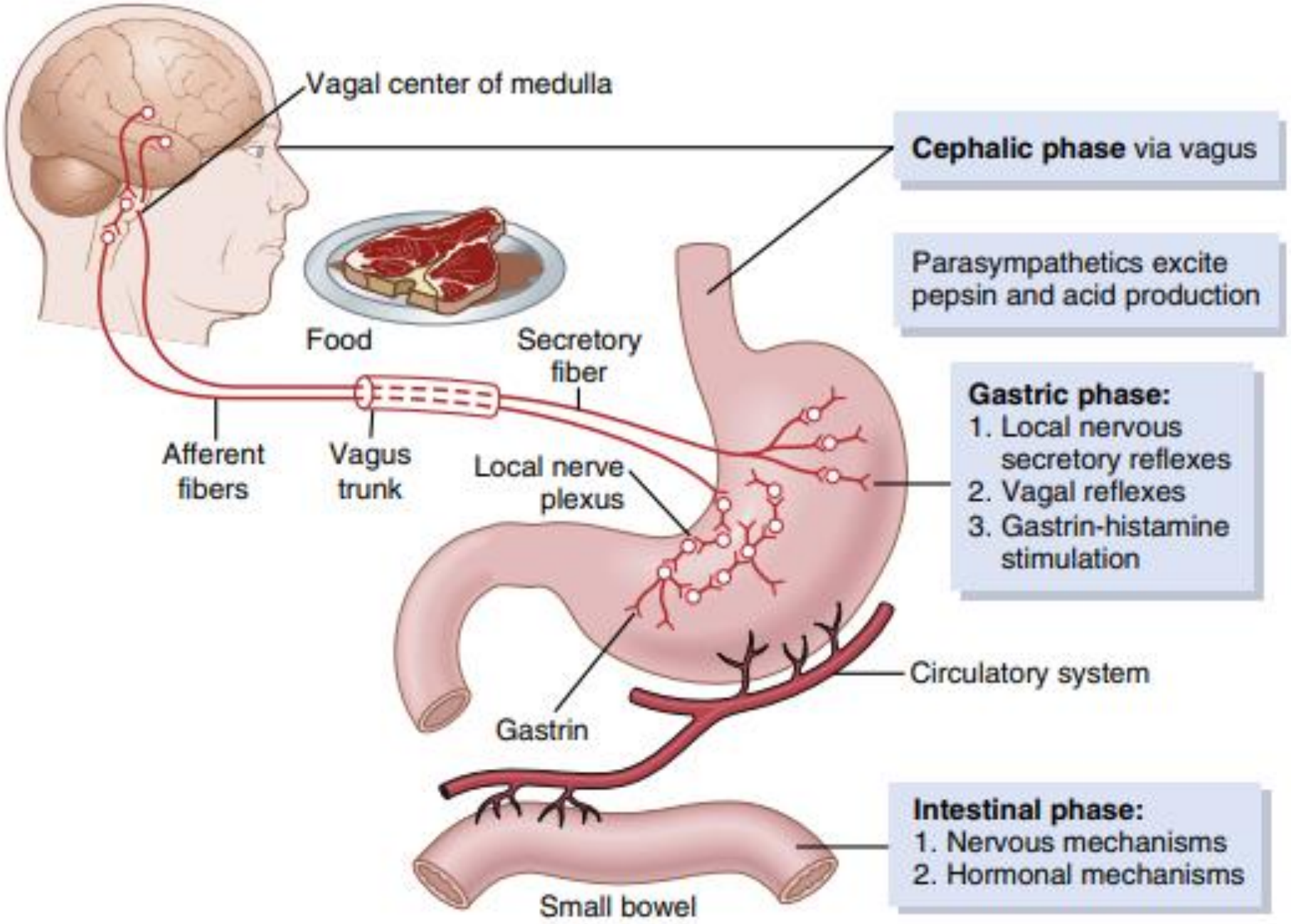


Figure :

Phases of gastric secretion and their regulation


Thank
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