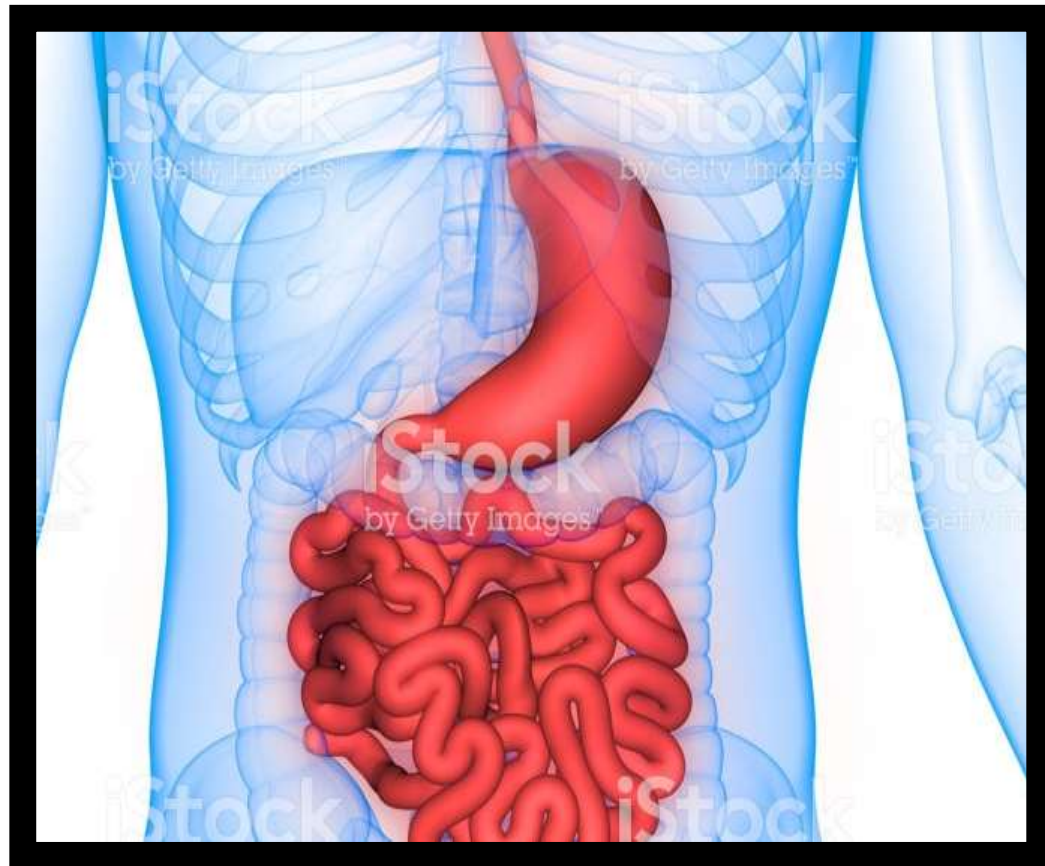


GASTROINTESTINAL SYSTEM

[Anatomy and functions of stomach]

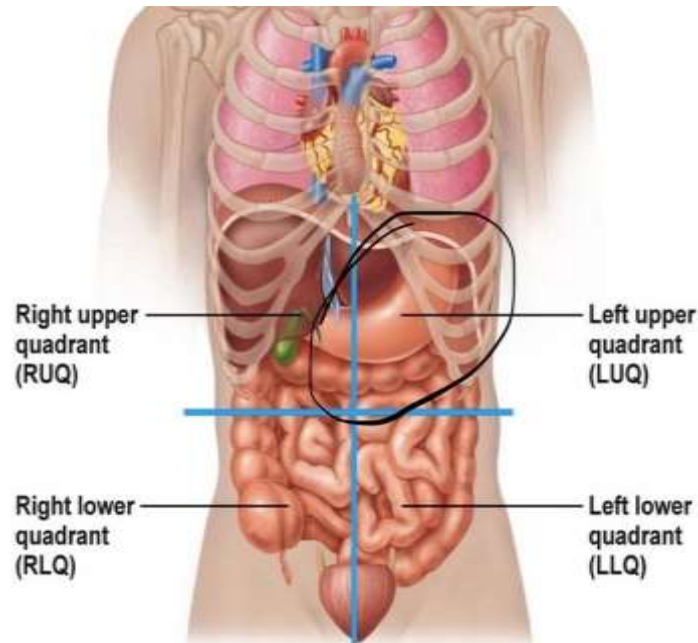


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INTRODUCTION

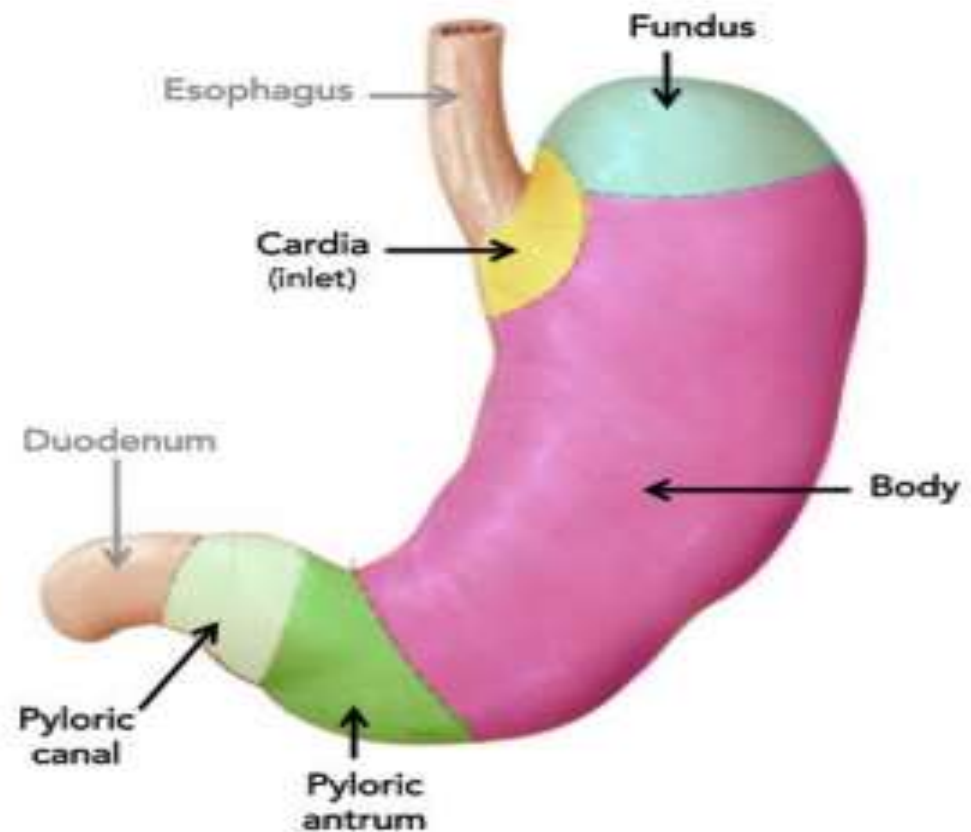
- Stomach is a hollow organ situated just below the diaphragm on the left side (left upper quadrant) in the abdominal cavity. Volume of empty stomach is 50 mL.
- Under normal conditions, it can expand to accommodate 1 L to 1.5 L of solids and liquids. However, it is capable of expanding still further up to 4 L.



PARTS OF STOMACH

In humans, stomach has four parts:

1. Cardia or cardiac region
2. Fundus
3. Body or corpus
4. Pyloric region.



1. Cardiac Region(cardiac end)

- Cardiac region is the upper part of the stomach where esophagus opens.
- The opening is guarded by a sphincter called **cardiac sphincter**, which opens only towards stomach.

2. Fundus

- Fundus is a small dome shaped structure.
- It is elevated above the level of esophageal opening.

3. Body or Corpus

- Body is the largest part of stomach forming about 75% to 80% of the whole stomach.
- It extends from just below the fundus up to the pyloric region.

4. Pyloric Region

- Pyloric region has two parts, antrum and pyloric canal.
- The body of stomach ends in **antrum**.
- Antrum is continued as the narrow canal, which is called **pyloric canal or pyloric end**.
- **Pyloric** canal opens into first part of small intestine called duodenum.
- The opening of pyloric canal is guarded by a sphincter called pyloric sphincter. It opens towards duodenum.
- Stomach has two curvatures. One on the right side is lesser curvature and the other on left side is greater curvature.

STRUCTURE OF STOMACH WALL

Stomach wall is formed by four layers of structures:

*1. Outer serous layer: Formed by **peritoneum***

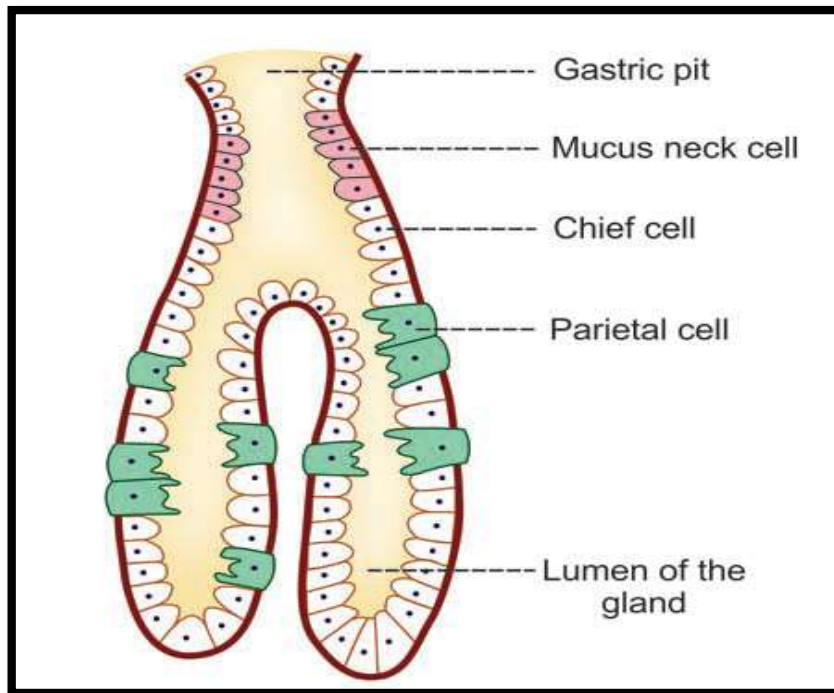
2. Muscular layer: Made up of three layers of smooth muscle fibers, namely inner oblique, middle circular and outer longitudinal layers

*3. Submucosa layer: Formed by areolar tissue, blood vessels, lymph vessels and **Meissner nerve plexus**.*

4. Inner mucus layer: Lined by mucus secreting columnar epithelial cells.

GLANDS OF STOMACH – GASTRIC GLANDS

Glands of the stomach or gastric glands are tubular structures made up of different types of cells. These glands open into the stomach cavity via gastric pits.

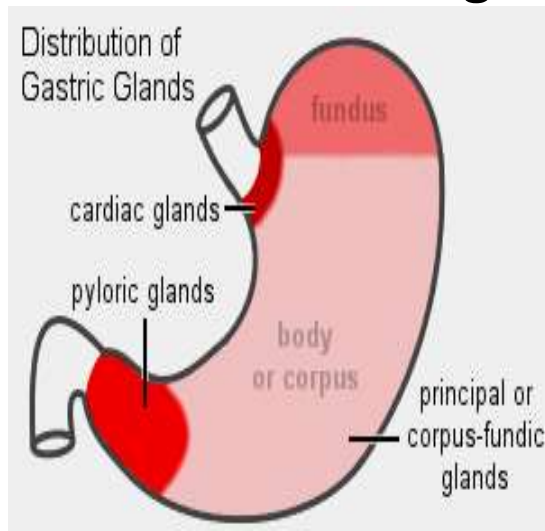


Stained section of pyloric region of stomach

CLASSIFICATION OF GLANDS OF THE STOMACH

Gastric glands are classified into three types, on the basis of their location in the stomach:

1. Fundic glands or main gastric glands or oxyntic glands:
Situated in body and fundus of stomach
2. Pyloric glands: Present in the pyloric part of the stomach
3. Cardiac glands: Located in the cardiac region of the stomach.



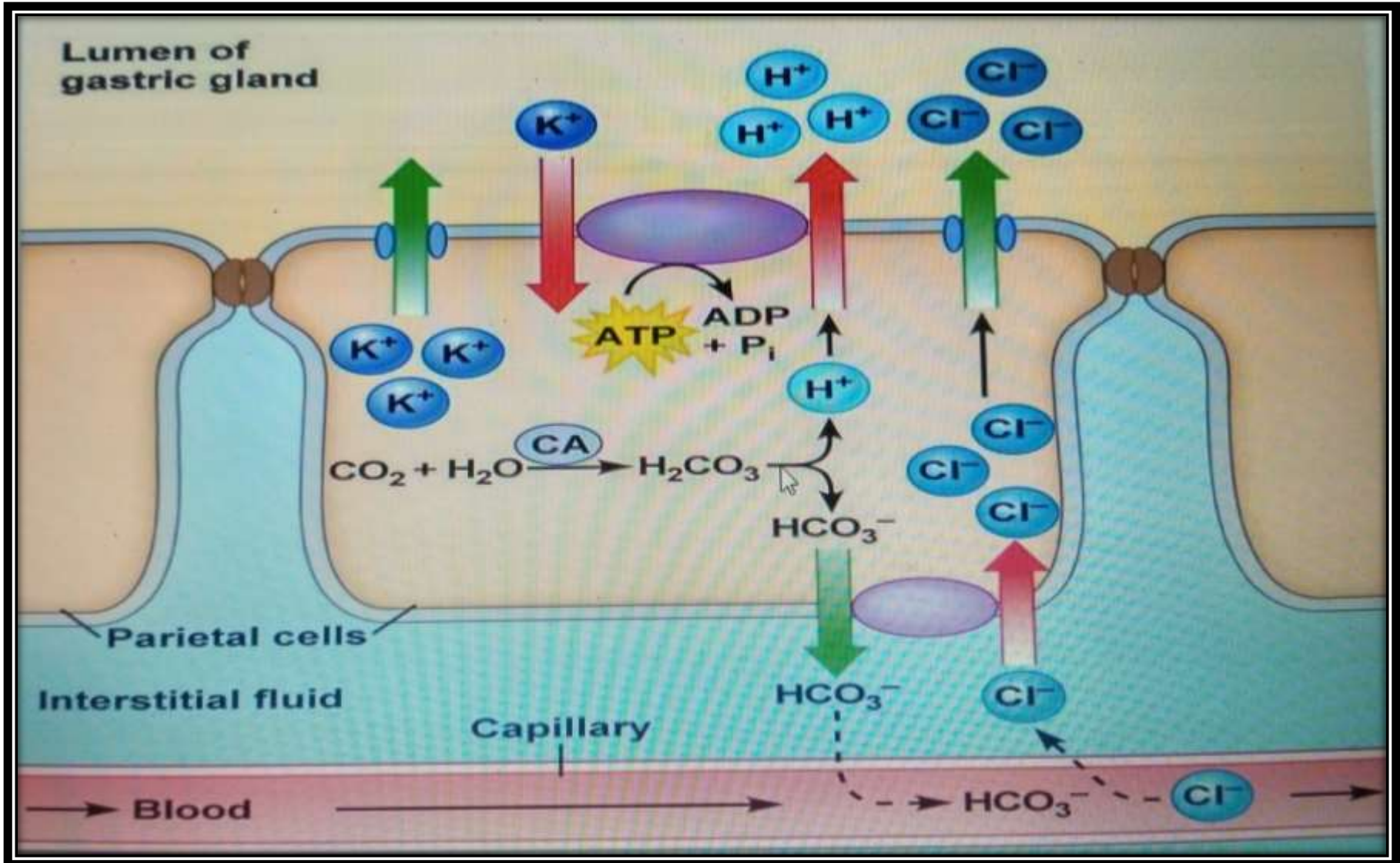
FUNCTIONS OF THE STOMACH

These include:

- Temporary storage allowing time for the digestive enzymes, pepsins, to act .
- Chemical digestion — pepsins convert proteins to polypeptides
- Mechanical breakdown — the three smooth muscle layers enable the stomach to act as a churn, gastric juice is added and the contents are liquefied to *chyme*
- Limited absorption- water, alcohol and some lipidsoluble drugs
- Non-specific defence against microbes — provided by hydrochloric acid in gastric juice. Vomiting may be a response to ingestion of gastric irritants, e.g. microbes or chemicals

- Preparation of iron for absorption further along the tract — the acid environment of the stomach solubilises iron salts, which is required before iron can be absorbed
- Production of intrinsic factor needed for absorption of vitamin B12 in the terminal ileum
- Regulation of the passage of gastric contents into the duodenum. When the chyme is sufficiently acidified and liquefied, the pyloric antrum forces small jets of gastric contents through the pyloric sphincter into the duodenum.

PHYSIOLOGY OF HCl SECRETION



Mechanism (physiology) of HCl secretion:

- It takes place in the canaliculi of parietal cells in gastric glands.
- CO_2 derived from metabolic activities combines with H_2O to form carbonic acid in presence of carbonic anhydrase(CA).
- Carbonic acid which is unstable split into hydrogen and bicarbonate ions.
- Hydrogen ion is actively pumped into canaliculus of parietal cells in exchange of K^+ through action of H^+/K^+ ATP ase pump.
- Simultaneously Cl^- from ECF is also pumped into the canaliculi actively(Cl^- derived from NaCl in blood).
- H^+ and Cl^- combines to form HCl .

➤ To compensate the loss of chloride ion, the bicarbonate ion from parietal cells enters blood and combine with Na to form NaHCO_3

Factors stimulating acid secretion:

- Gastrin
- Histamine
- Vagal stimulation

Factors inhibiting acid secretion:

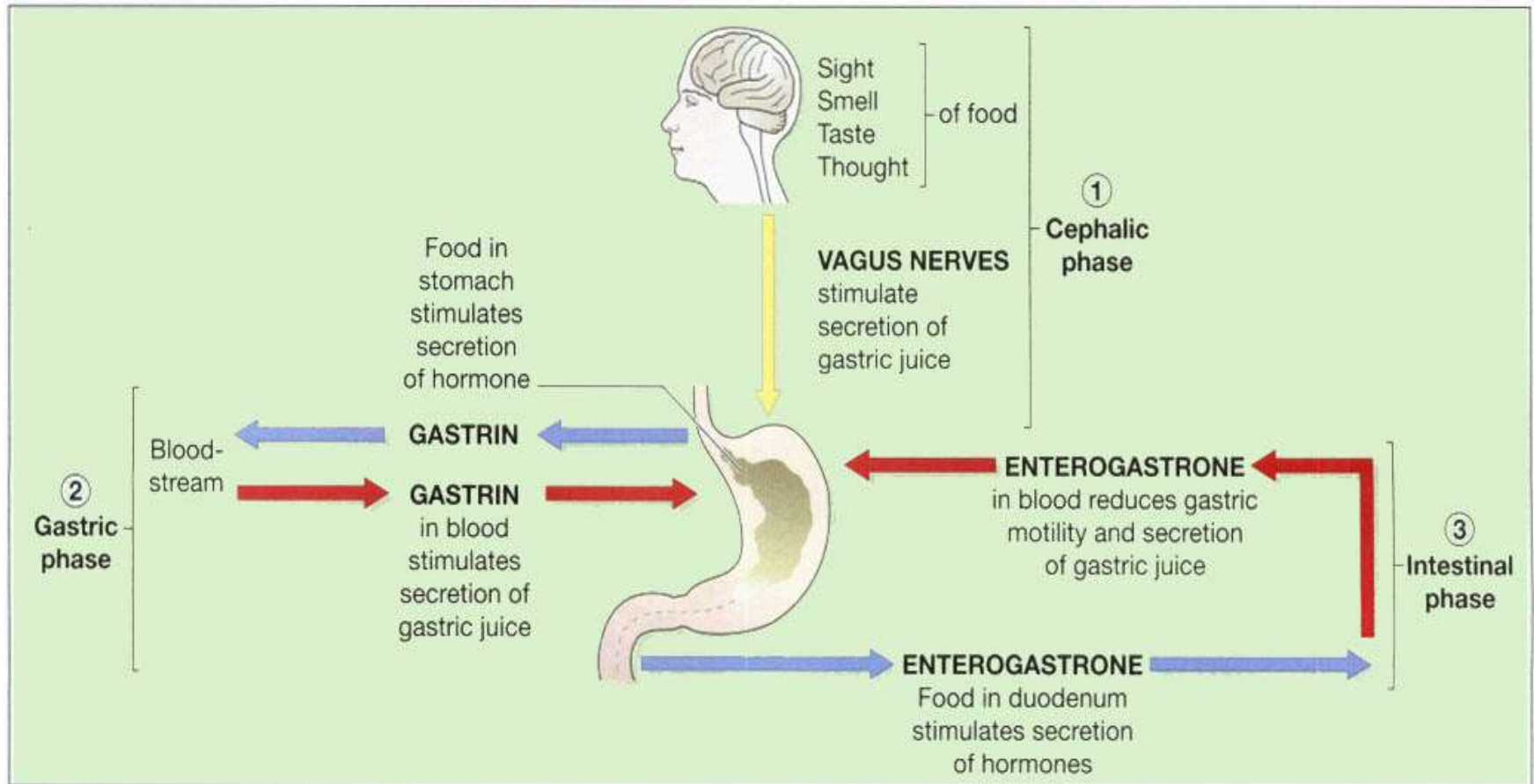
- Secretin
- Gastric inhibitory peptide

Gastric juice

It is secreted by gastric gland. About 2 litres of gastric juice are secreted daily by special secretory glands in the mucosa . It consists of:

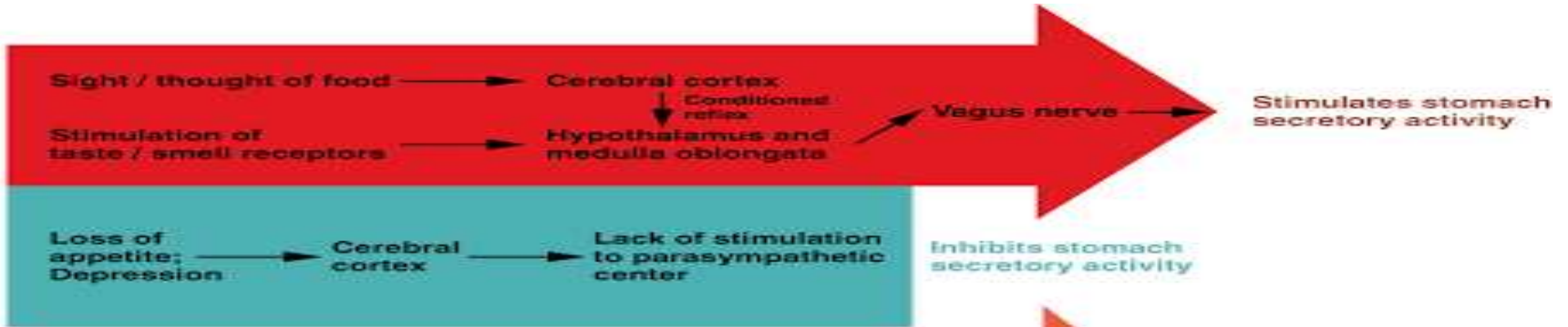
- Water
- Mineral salts
- Mucus secreted by goblet cells in the glands and on the stomach surface
- Hydrochloric acid
- *Intrinsic factor*
- Inactive enzyme precursors: pepsinogens secreted by *chief cells in the glands.*

Phases of secretion of gastric juice: three phases

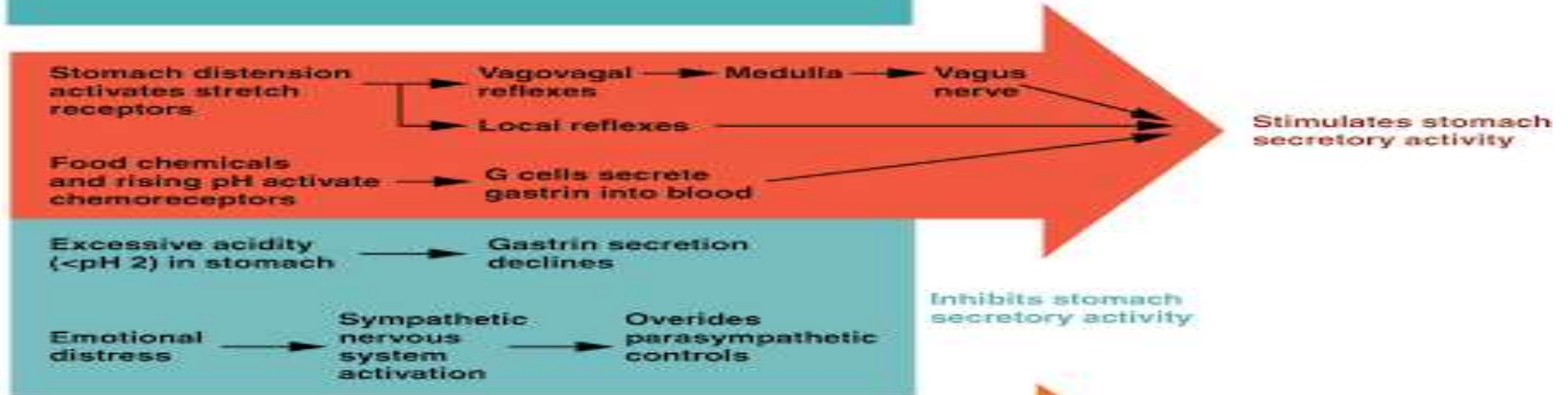


REGULATION OF PANCREATIC SECRETION BY PARASYMPATHETIC NERVOUS SYSTEM

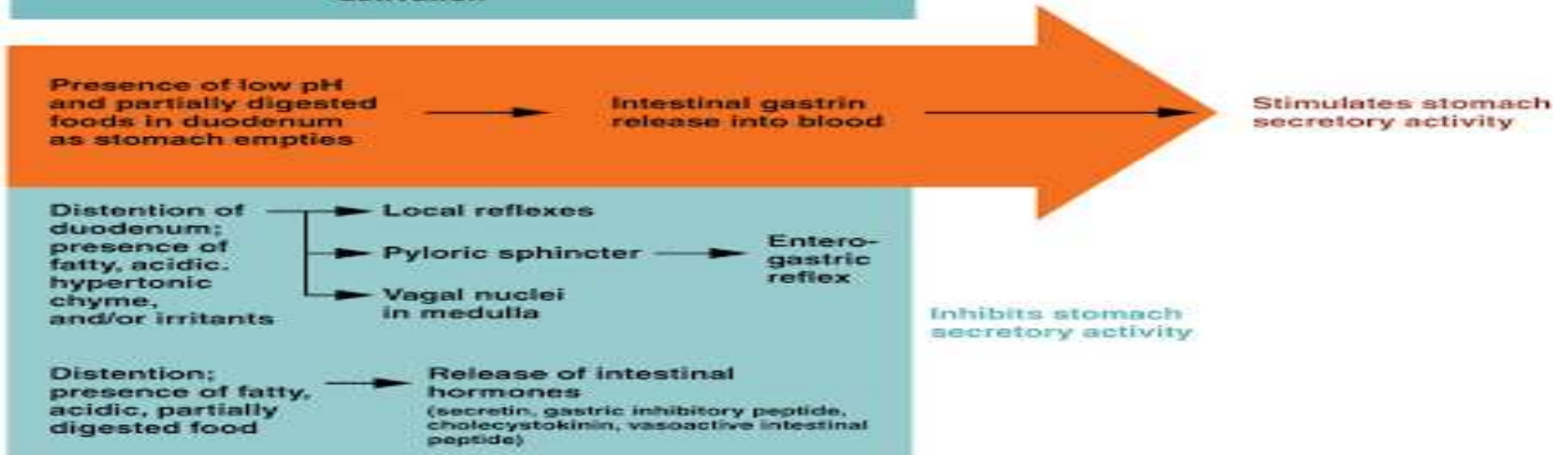
CEPHALIC PHASE



GASTRIC PHASE



INTESTINAL PHASE



Pepsin role in protein digestion

- Zymogen: They are digestive enzymes secreted as inactive proteins. They are converted to active enzymes by removing some of their amino acids.
- Pepsinogen: It is a zymogen secreted by the chief cells. HCl removes some of its amino acids and forms an enzyme pepsin that digests proteins.
- In stomach: passage of food into stomach stimulates gastric mucosa to secrete a polypeptide hormone called Gastrin.

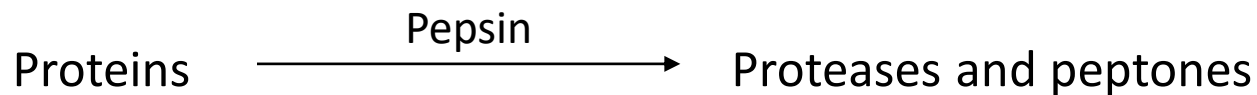
The gastrin has the following actions:

1- Stimulate the chief cells of gastric mucosa to secrete the inactive zymogen “pepsinogen”.

2- Stimulates the parietal cells of gastric mucosa to secrete HCl which activates pepsinogen into pepsin which activates more pepsinogen “autoactivation”.

Pepsin is an endopeptidase, partially hydrolyse the ingested proteins into polypeptides.

- Pepsin is an active proteolytic enzyme in a highly acidic medium (optimum pH=2.0) but above a pH of about 5 it has little proteolytic activity and soon becomes completely inactivated.
- HCl is necessary as pepsin for protein digestion in stomach.
- Pepsin catalyses the hydrolysis of bonds formed by carboxyl groups of Phe, Tyr, Trp, Met.
- By the action of pepsin, proteins are broken into proteases and peptones.



Digestion of proteins

Dietary proteins

Mouth, stomach

Denatured and partially hydrolyzed protein

Small intestine

Trypsin, chymotrypsin,
Aminopeptidase, carboxy peptidase

Small peptides, aminoacids

Active transport

Intestinal lining

Amino acids in blood stream

DIGESTION OF PROTEIN

1. Protein digestion in stomach

Pepsinogen + HCl  **pepsin**
(inactive) (active)

Protein + water  **polypeptide (peptide)**

Milk  **casein + water**

Casein  **polypeptide + amino acids**