



# Physiology of the Stomach & Regulation of Gastric Secretion

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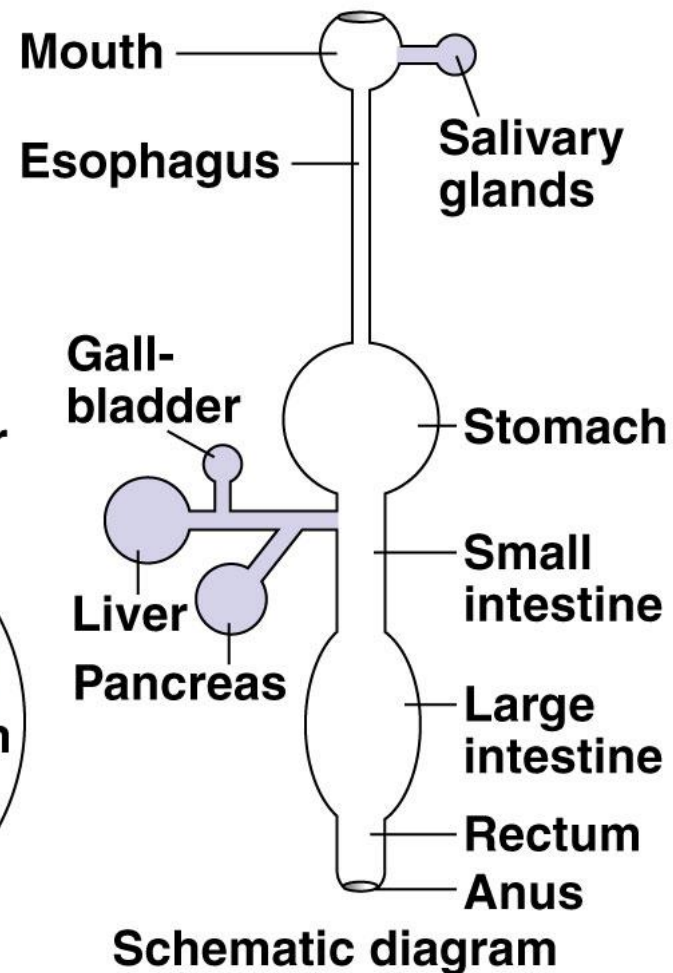
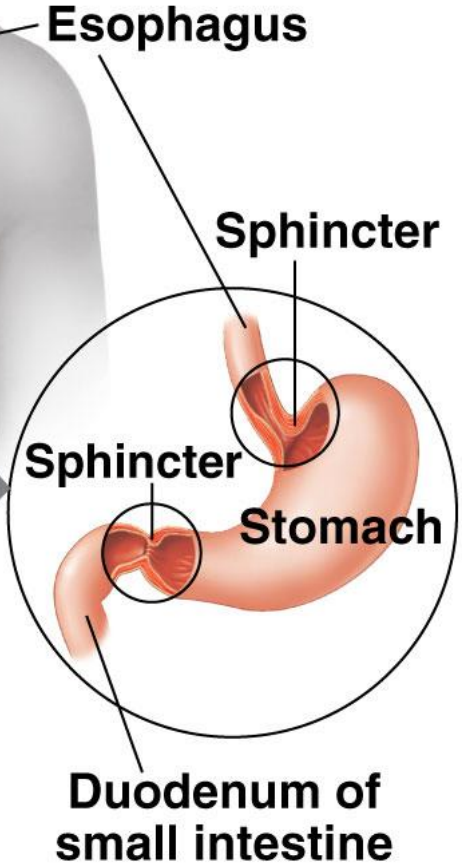
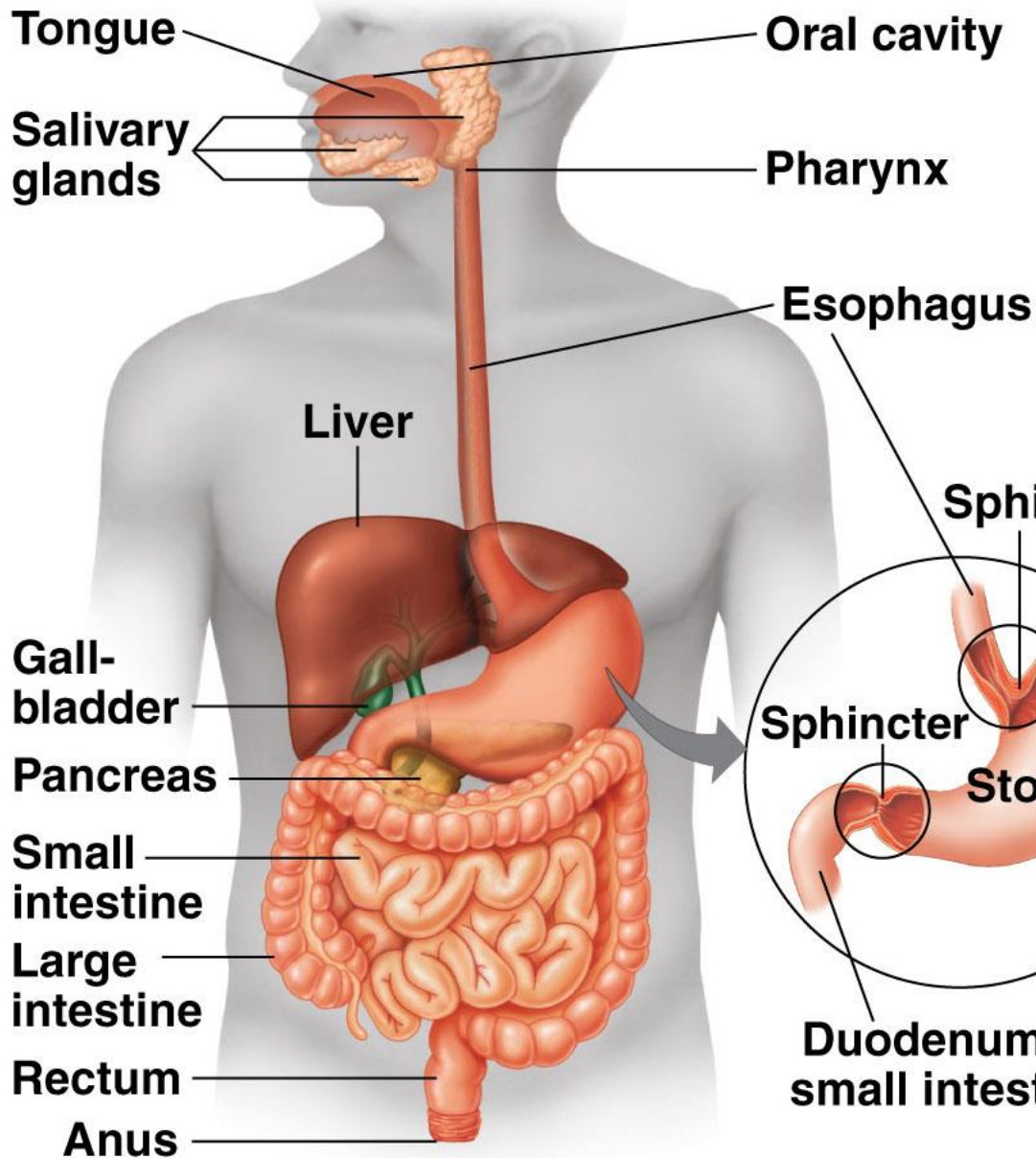
Maha Saja  
[msaja@ksu.edu.sa](mailto:msaja@ksu.edu.sa)

A stylized, colorful illustration of the human digestive system. It shows the esophagus (orange), liver (red), gallbladder (green), stomach (purple), small intestine (green), and large intestine (orange).

# Objectives

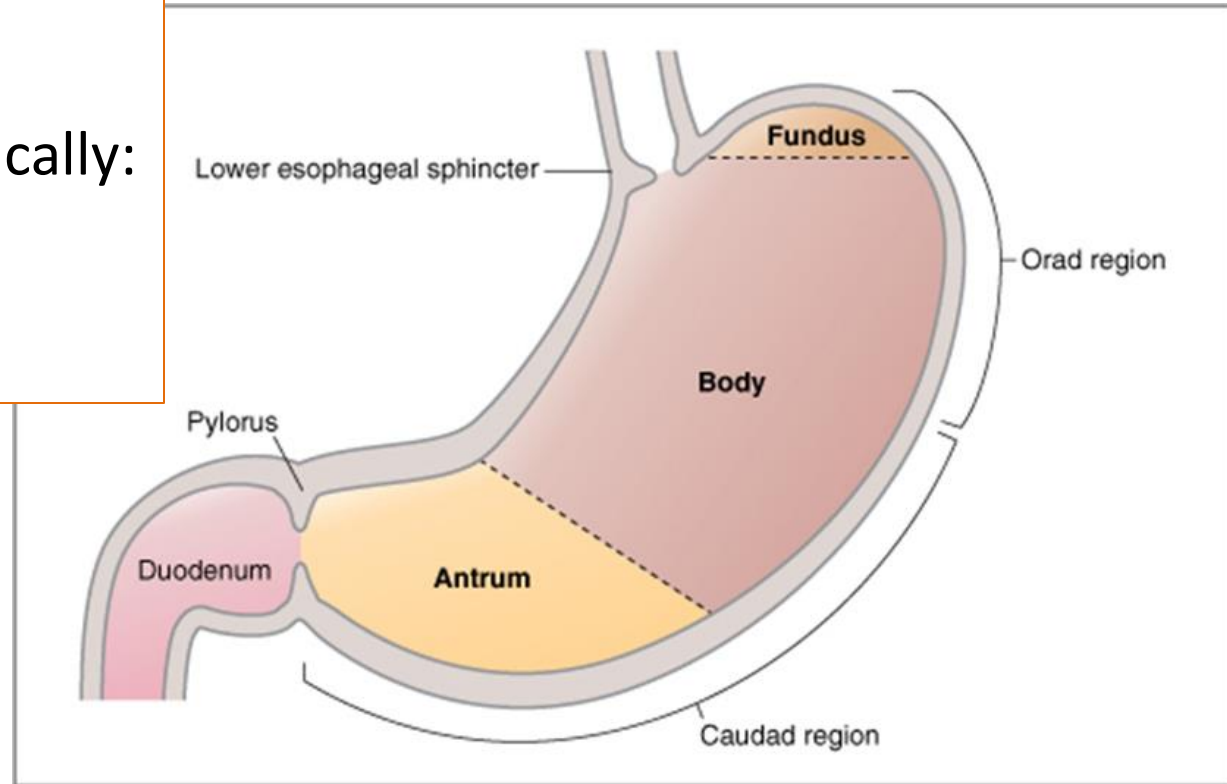
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- Functions of stomach.
- Gastric secretion.
  - ✓ Mechanism of HCl formation.
  - ✓ Gastric digestive enzymes.
  - ✓ Neural & hormonal control of gastric secretion.
  - ✓ Phases of gastric secretion.
- Motor functions of the stomach.
- Stomach Emptying.



# Functional Anatomy of the Stomach

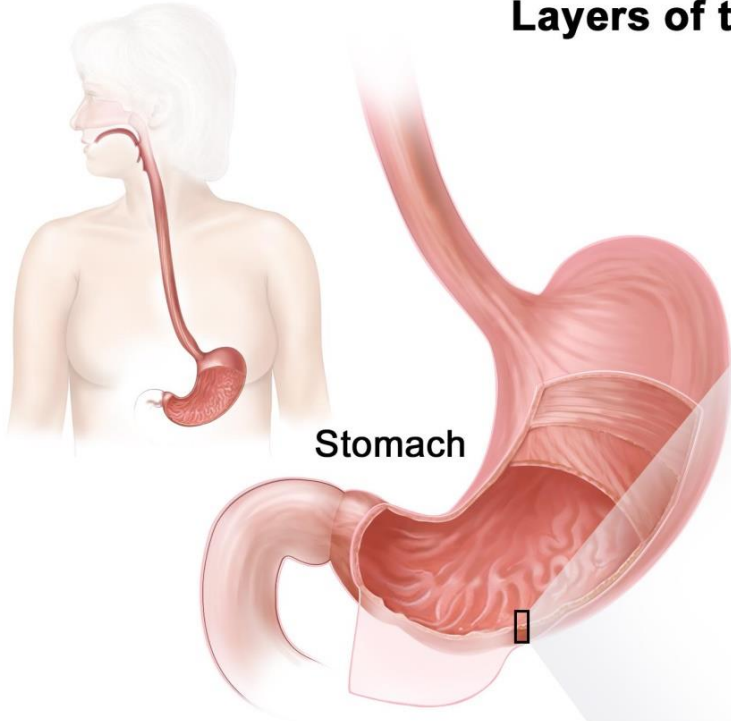
- Anatomically:
  - Body
  - Antrum
- Physiologically:
  - Orad
  - Caudad



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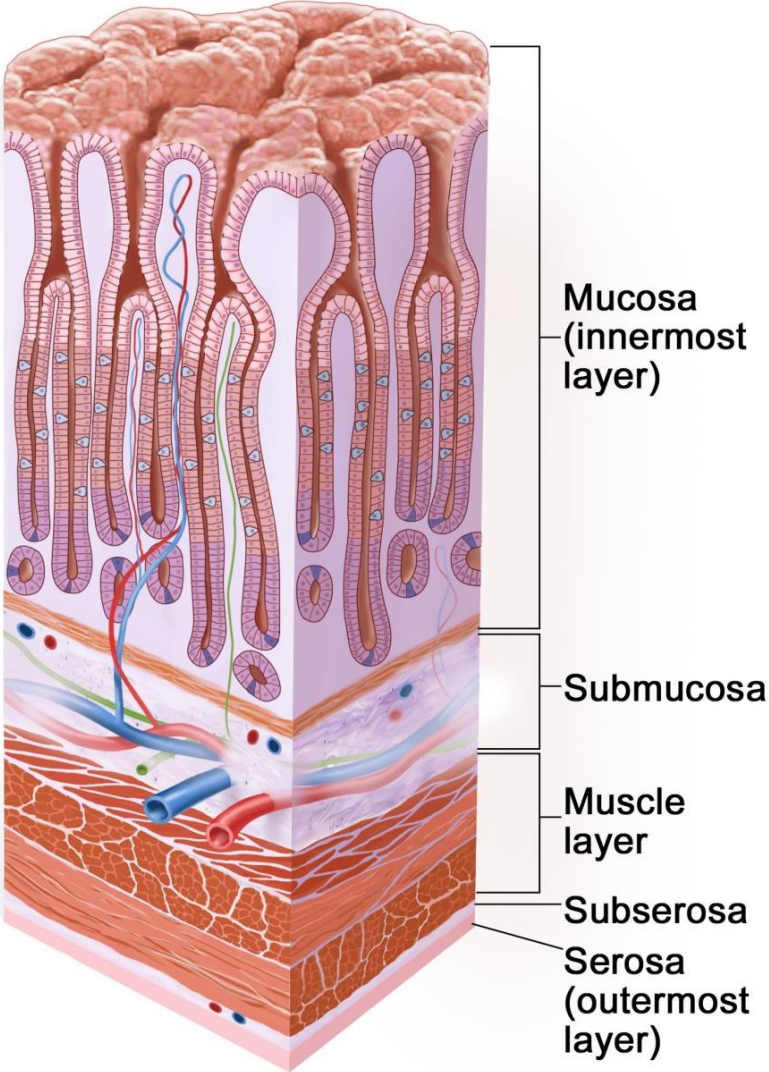
***What are the major functions of the stomach?***

# Layers of the Stomach Wall



Stomach

Inside of the stomach

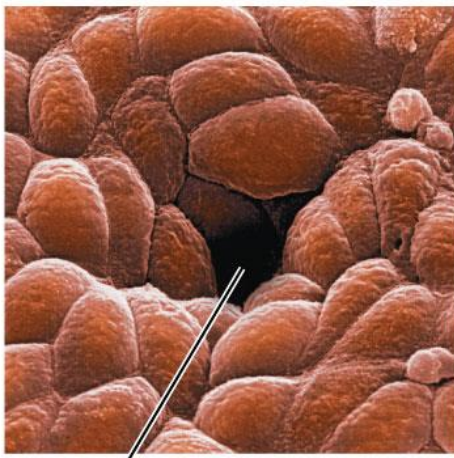


# Functional Anatomy of the Stomach

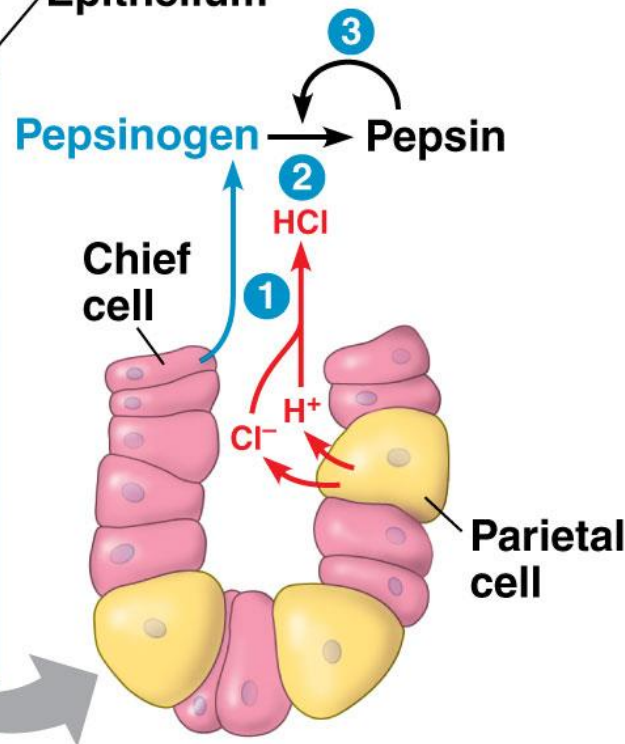
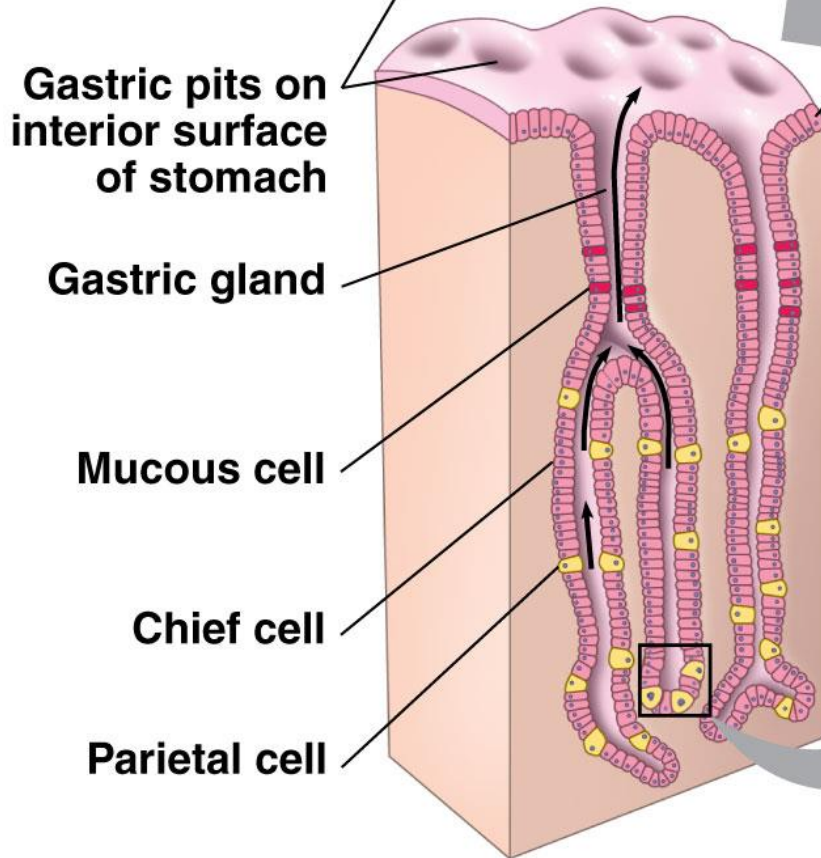
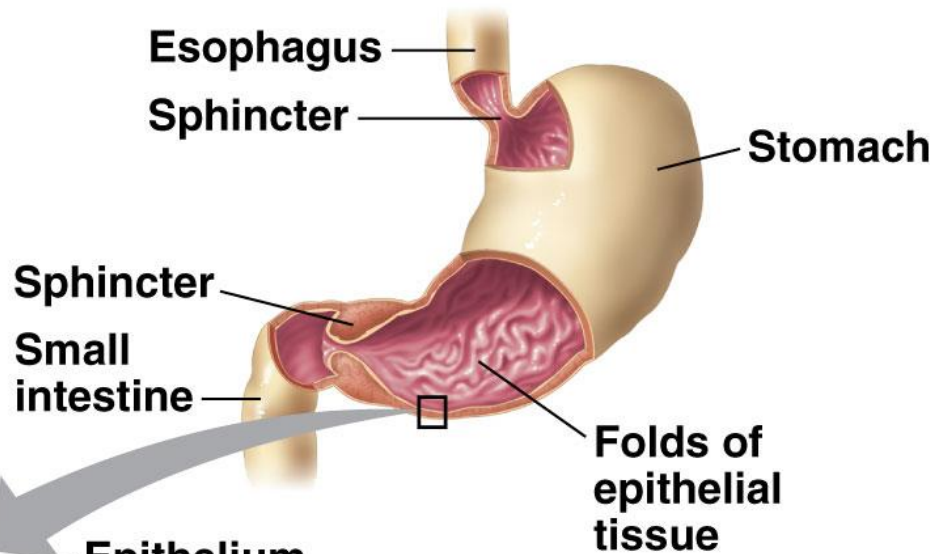
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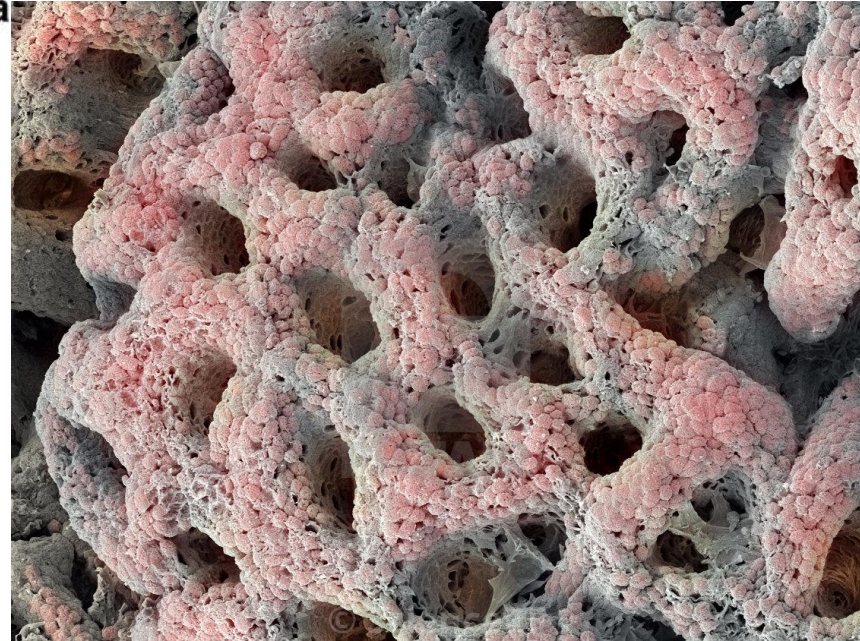
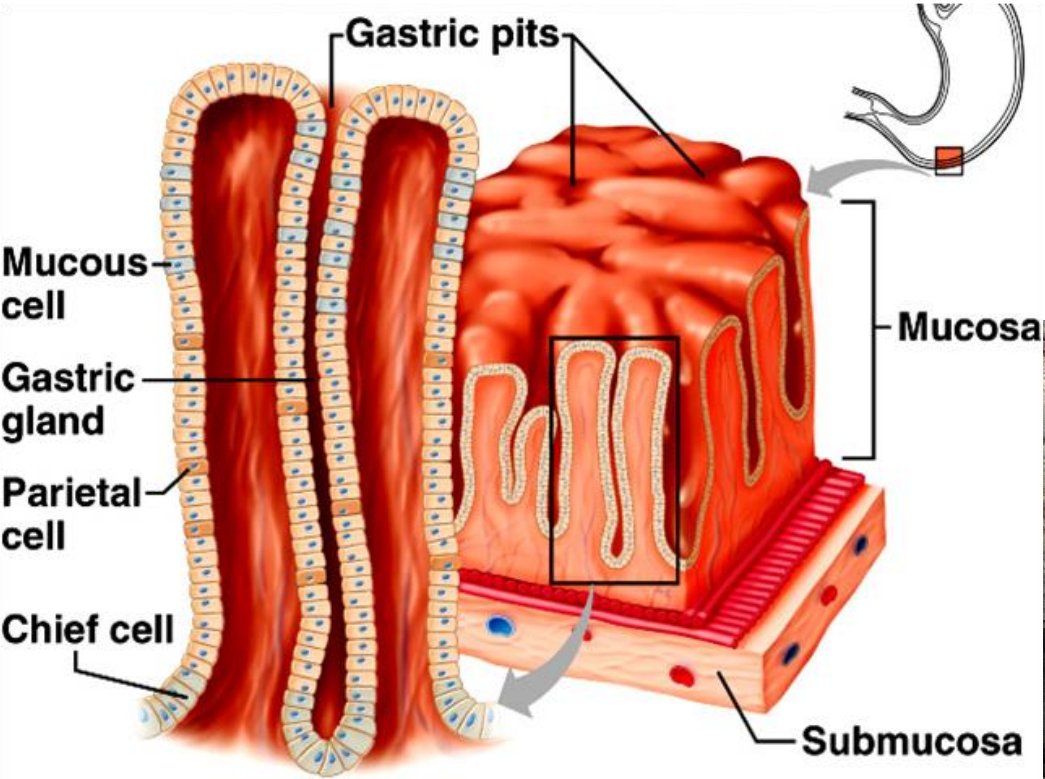


- Gastric mucosa is formed of columnar epithelium that is folded into “pits”.
- The pits are the opening of gastric glands.
- There are several types of gastric glands in the stomach and are distributed differentially in the stomach.



10  $\mu\text{m}$





Stomach lining with gastric pits, SEM  
 BStomach lining^b. Coloured scanning electron micrograph (SEM) of the inner lining of the stomach (gastric mucosa). The indents are gastric pits. These contain cells that secrete enzymes, mucous and hydrochloric acid into the stomach. Magnification: x40 when printed 10 centimetres wide.



# Types of Gastric Glands

## Gastric glands

### Mucus-secreting glands

**Secrete;**  
mucus  
HCO<sub>3</sub>

**Found in;**  
Cardia

### Oxyntic (parietal) glands

**Secrete;**  
HCl  
Pepsinogen  
IF  
Mucus

**Found in;**  
Body & fundus  
(above the notch)

### Pyloric glands

**Secrete;**  
Gastrin  
Mucus  
Pepsinogen

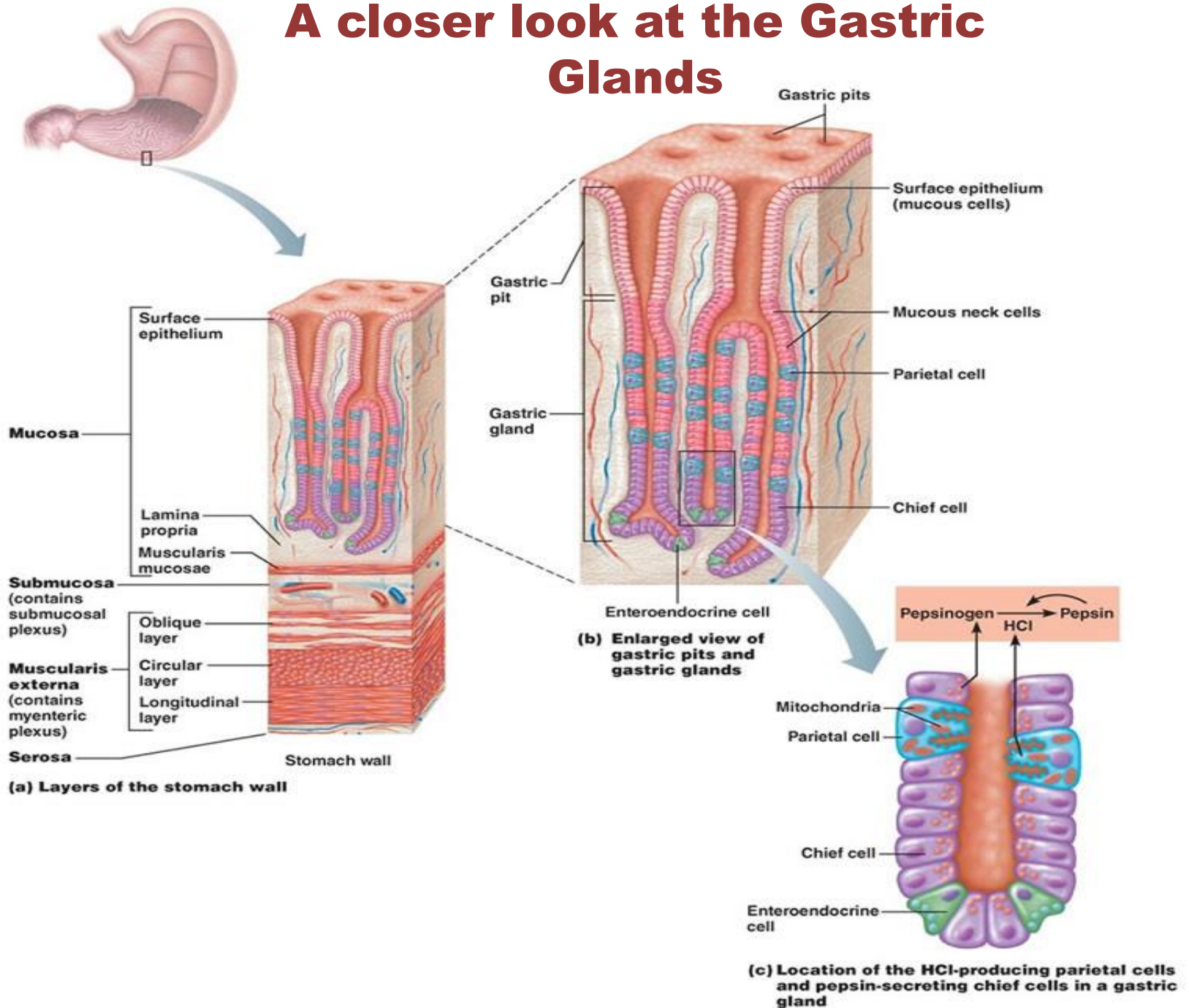
**Found in;**  
Antrum  
(below the notch)

**Distal 20% of stomach**

**Proximal 80% of stomach**



# A closer look at the Gastric Glands



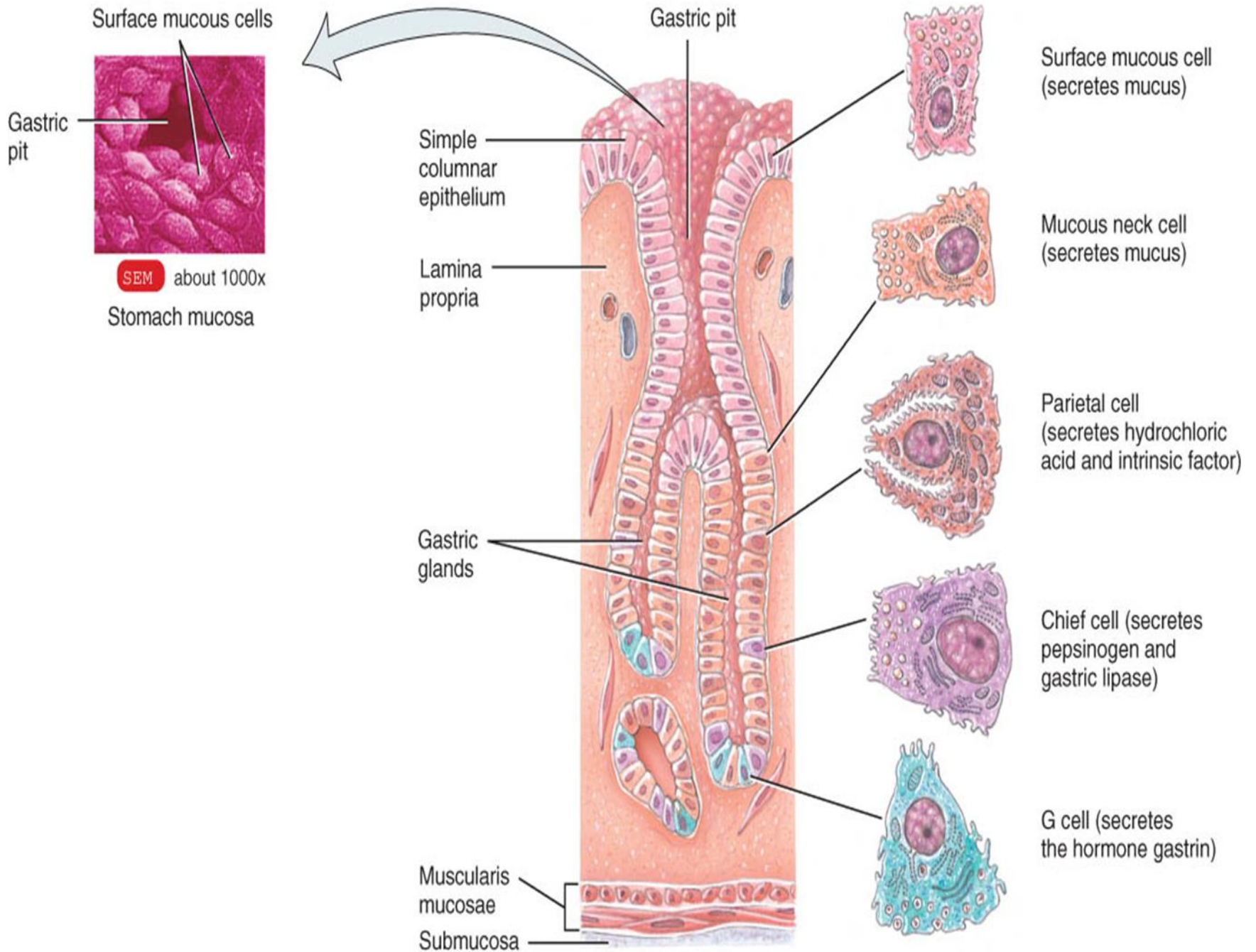
# Types of Cells Present in Gastric Glands

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Cell type	Secretion
Oxyntic (parietal) cell	HCL & IF (intrinsic factor)
Peptic (chief )cell	Pepsinogen
Mucus cells	Mucus
Enterochromaffin-like cells	Histamine
G cells	Gastrin

***What are enteroendocrine cells?***



(b) Sectional view of the stomach mucosa showing gastric glands and cell types

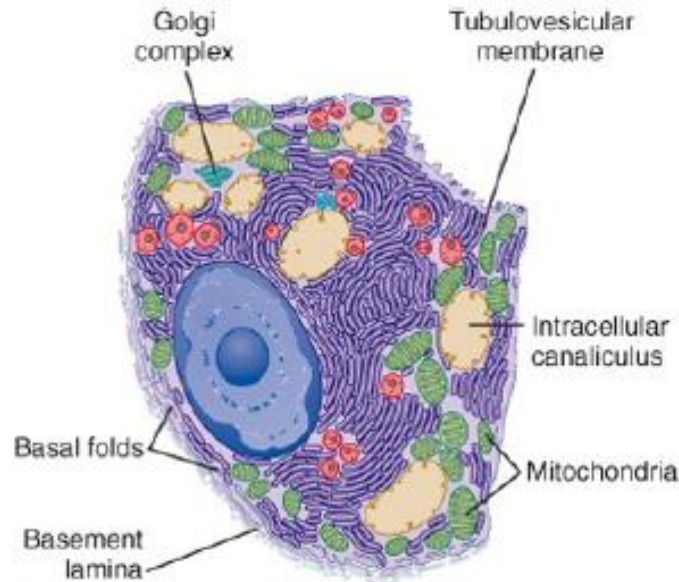


# Gastric Secretions

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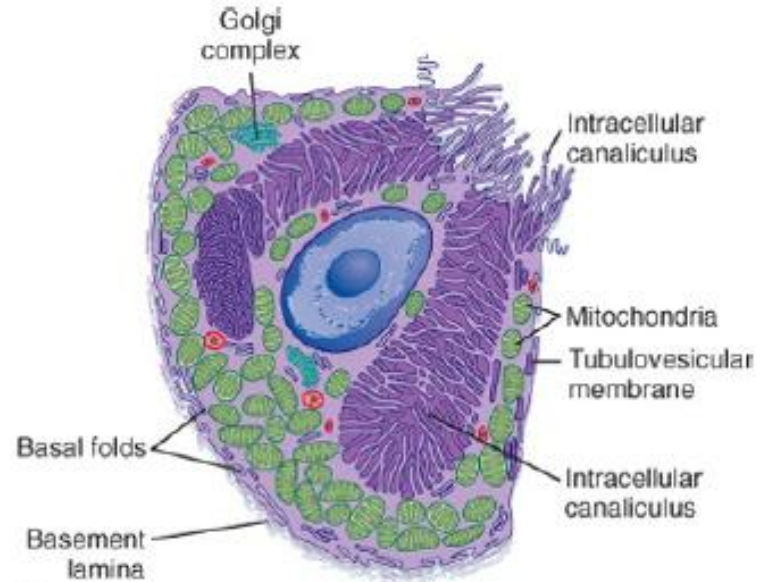
# Mechanism of HCl Secretion by Parietal Cells

## Resting PC



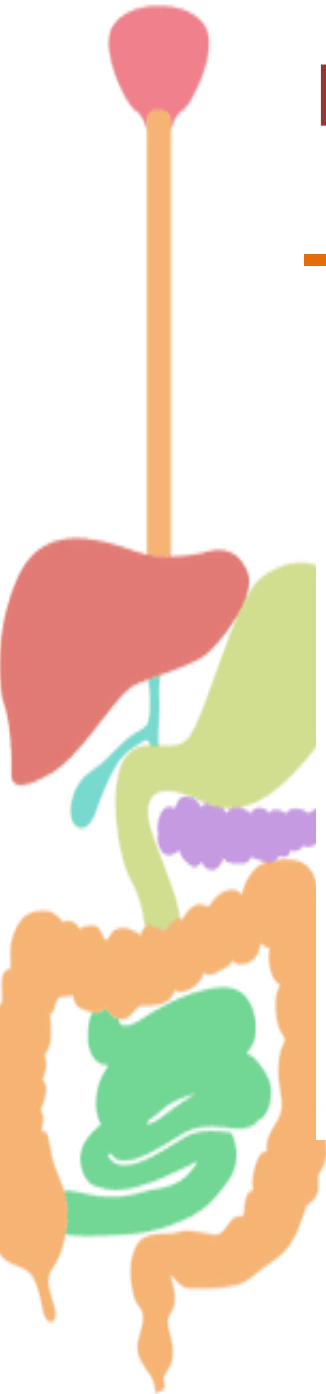
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## Active PC

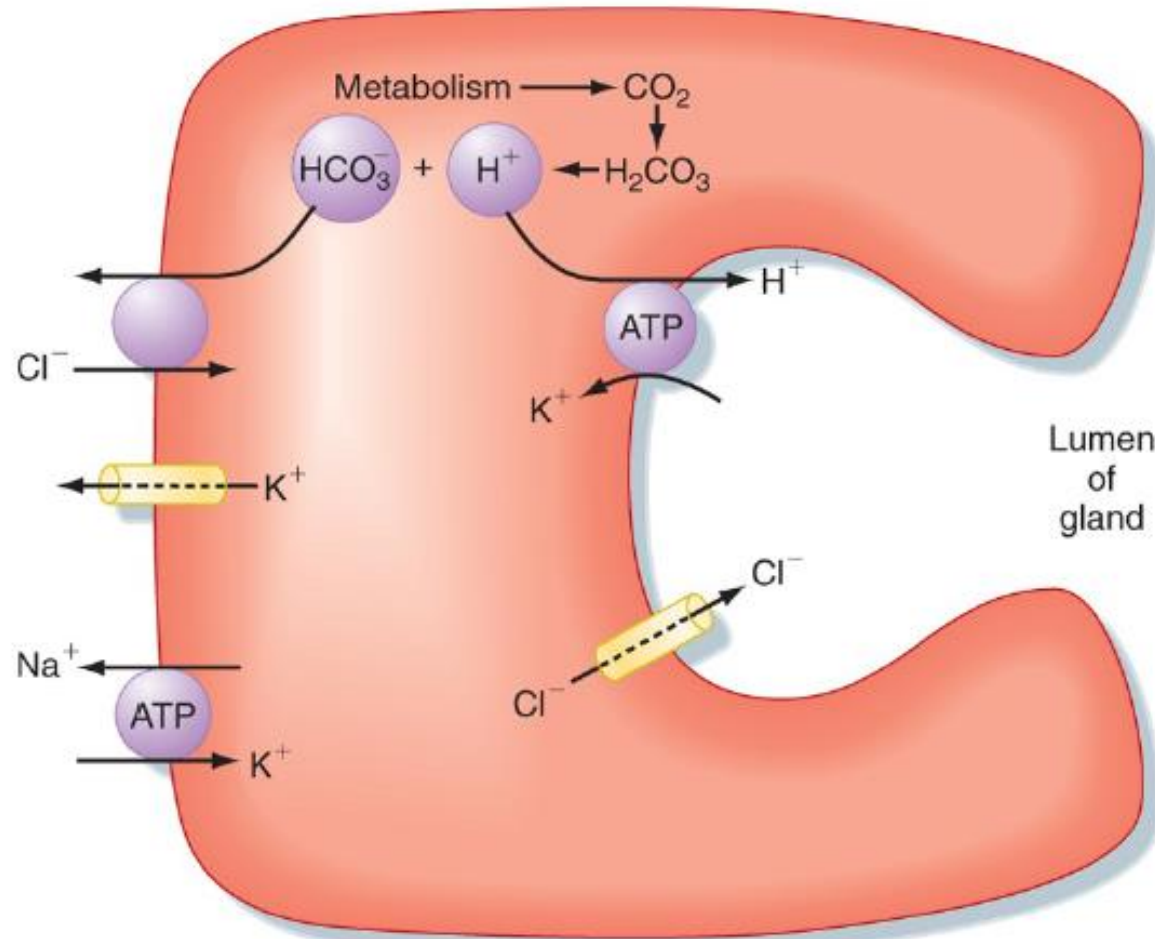


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Koeppen & Stanton: Berne and Levy Physiology, 6th Edition.  
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# Mechanism of HCl Secretion by Parietal Cells



Keppen & Stanton: Berne and Levy Physiology, 6th Edition.  
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Figure 28-4 Mechanism of  $\text{H}^+$  and  $\text{Cl}^-$  secretion by an activated parietal cell in the gastric mucosa.

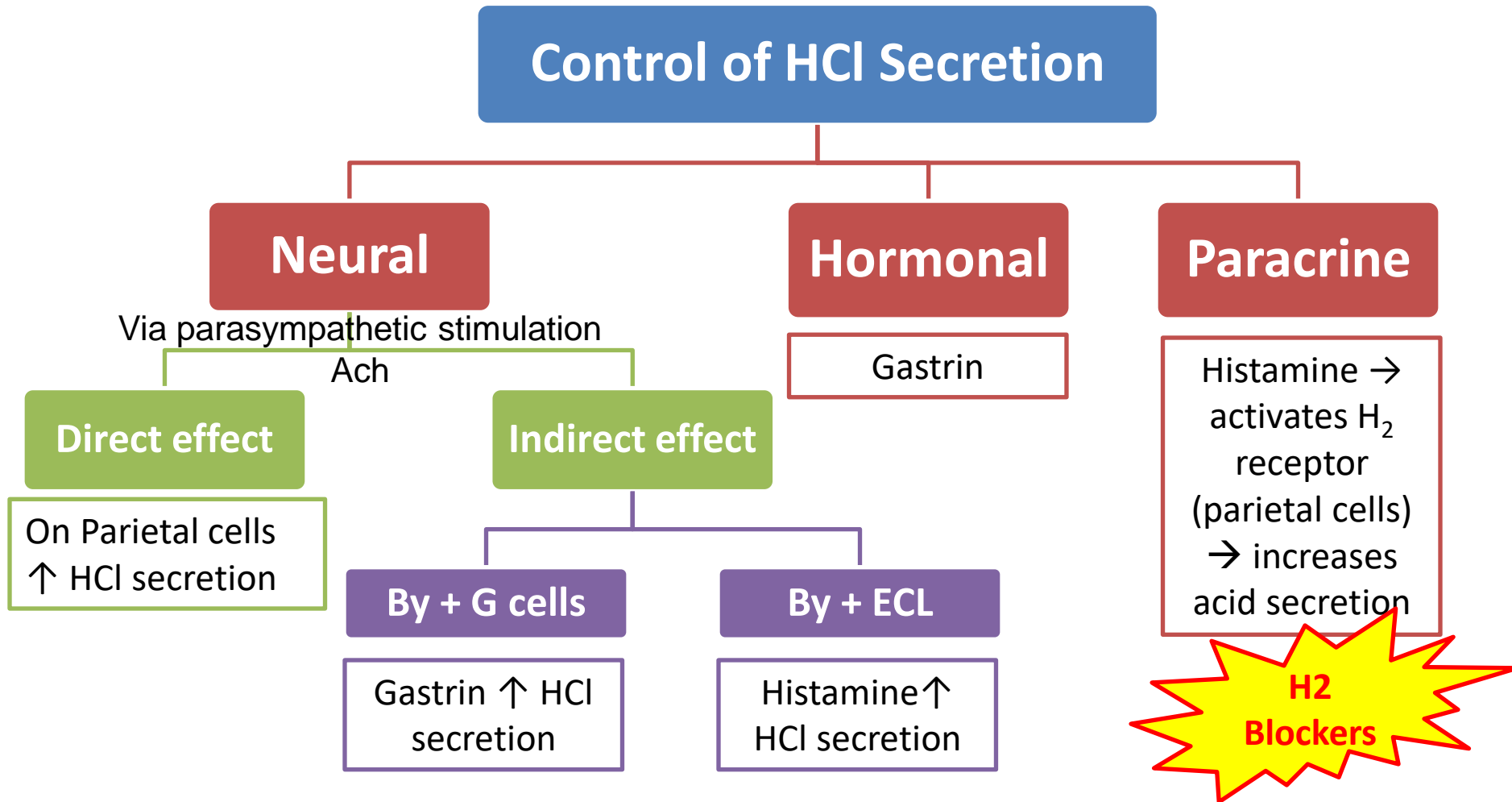


**A video on Mechanism of HCL secretion**

- <https://youtu.be/XhB7WNJVg3U>

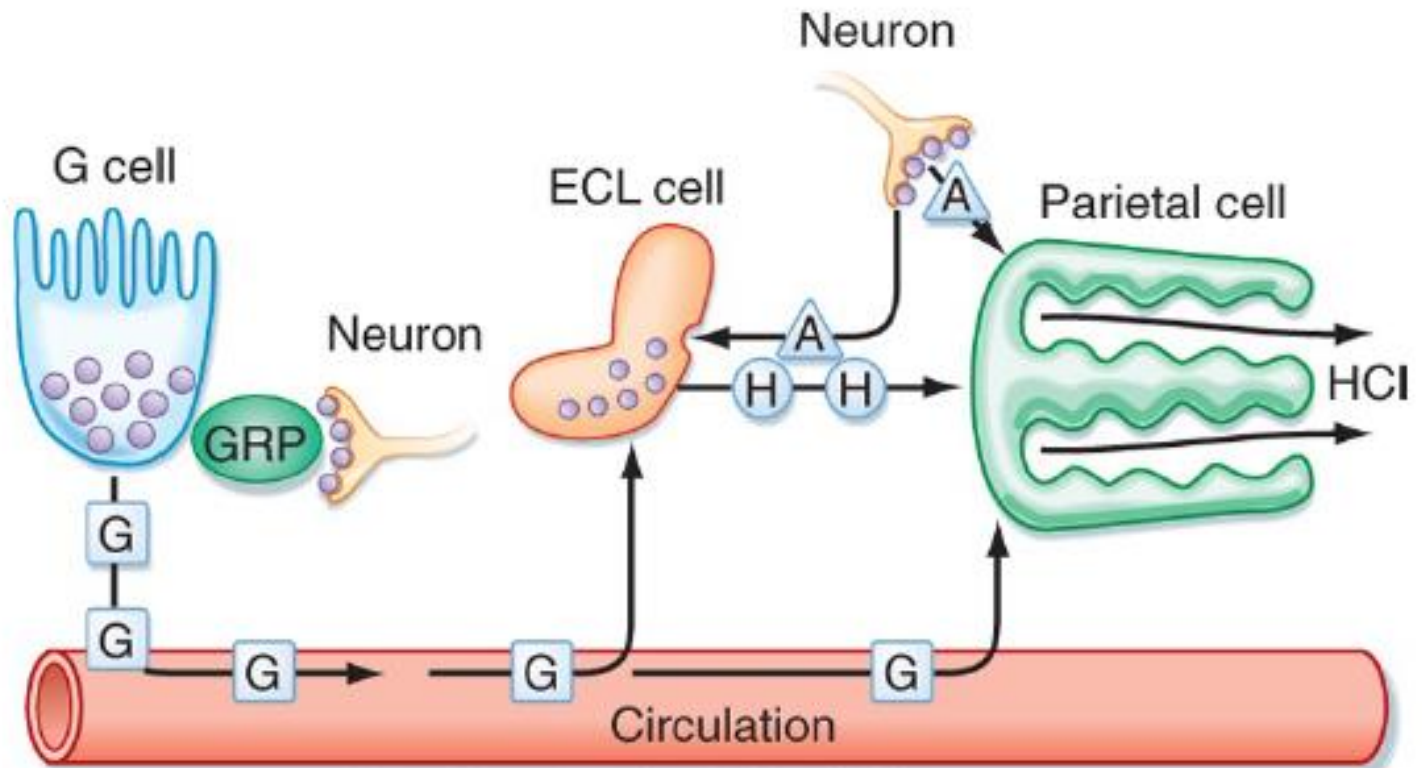


# Control of HCl Secretion

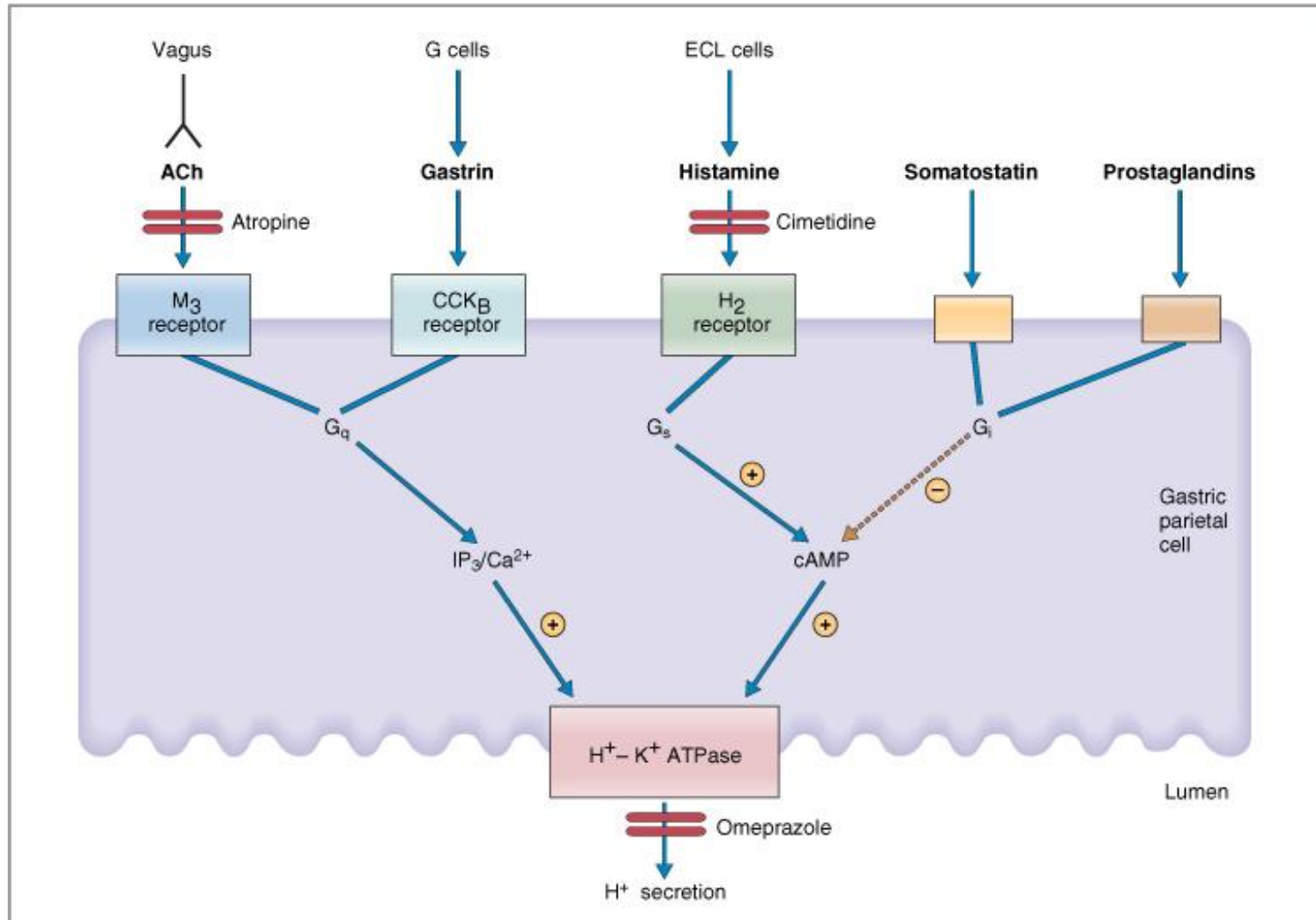


# Control of HCl Secretion

ACETYLCHOLINE, GASTRIN, AND HISTAMINE  
STIMULATE THE PARIETAL CELL



# Agents that stimulate and inhibit H<sup>+</sup> secretion by gastric parietal cells



# Other Gastric Secretions

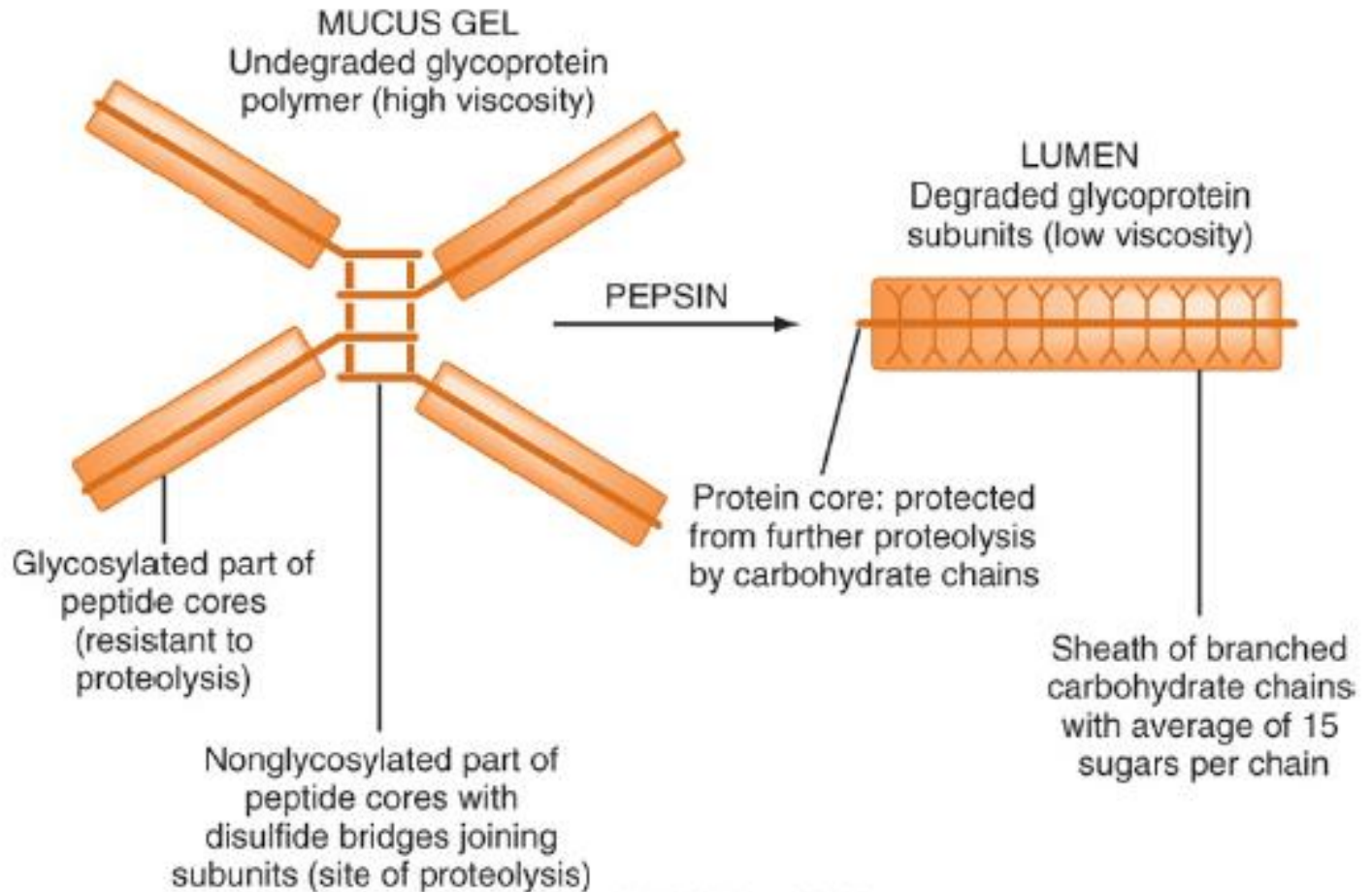
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- In addition to HCl, parietal cells secrete IF.. *What is its importance?*
- Peptic (chief) cells secrete pepsinogen.. *What is its role in digestion?*
- Mucus cells secrete mucus.. *Why?*



# Other Gastric Secretions- Mucus

page 000



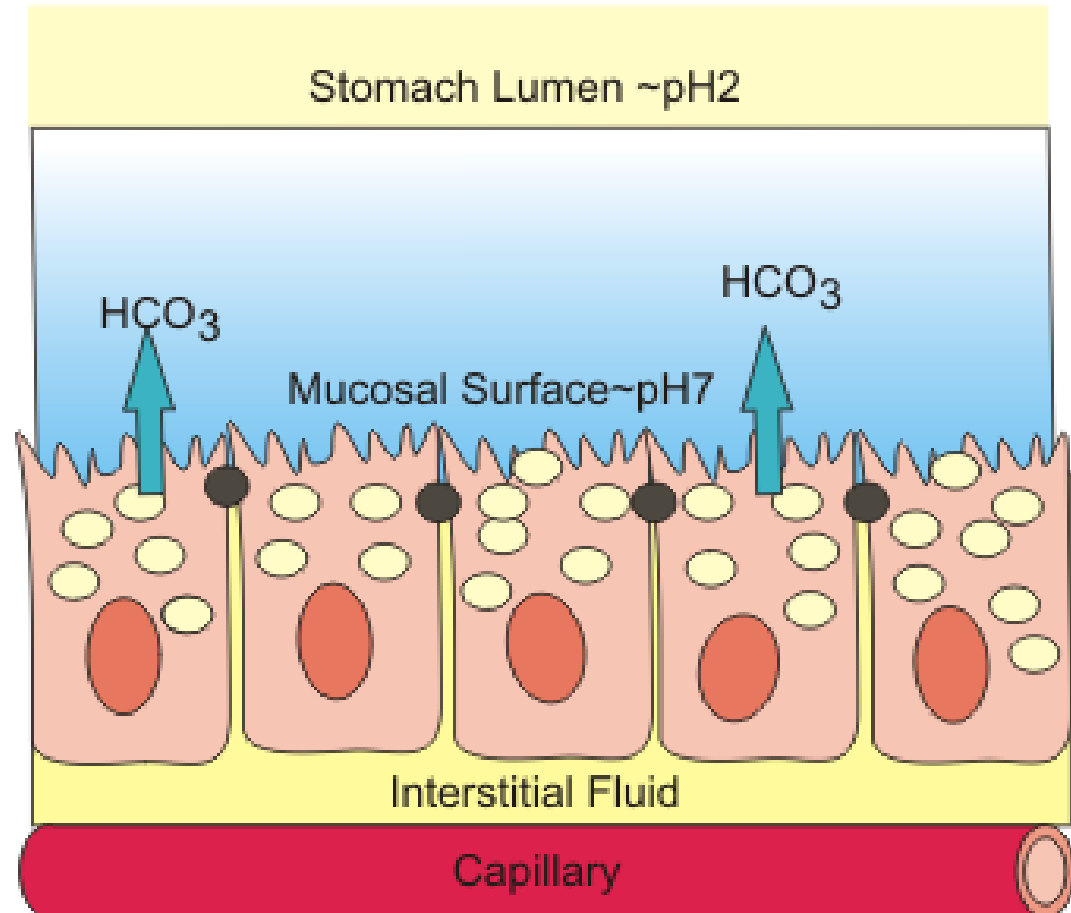
# The Mucus Layer of the Stomach

Bicarbonate –rich mucus layer protects the stomach mucosa



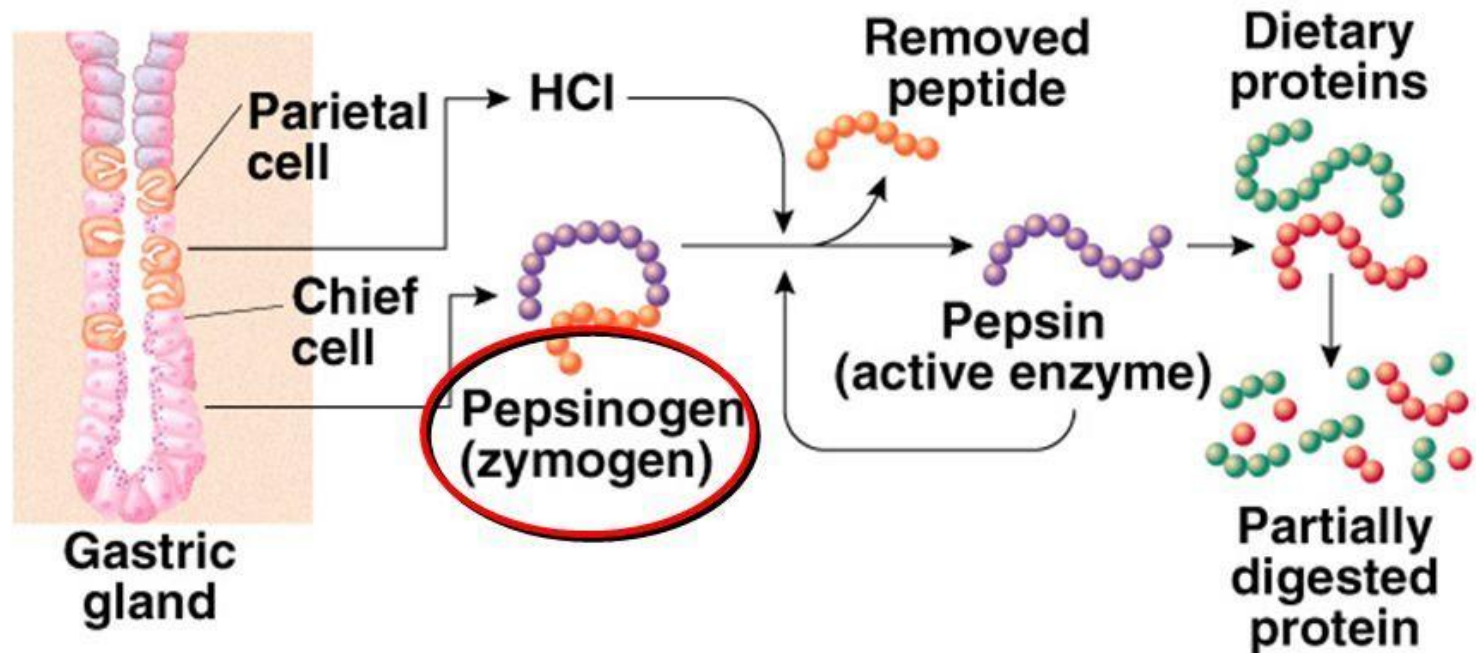
Mucous Layer

Mucous Cells



# Other Gastric Secretions

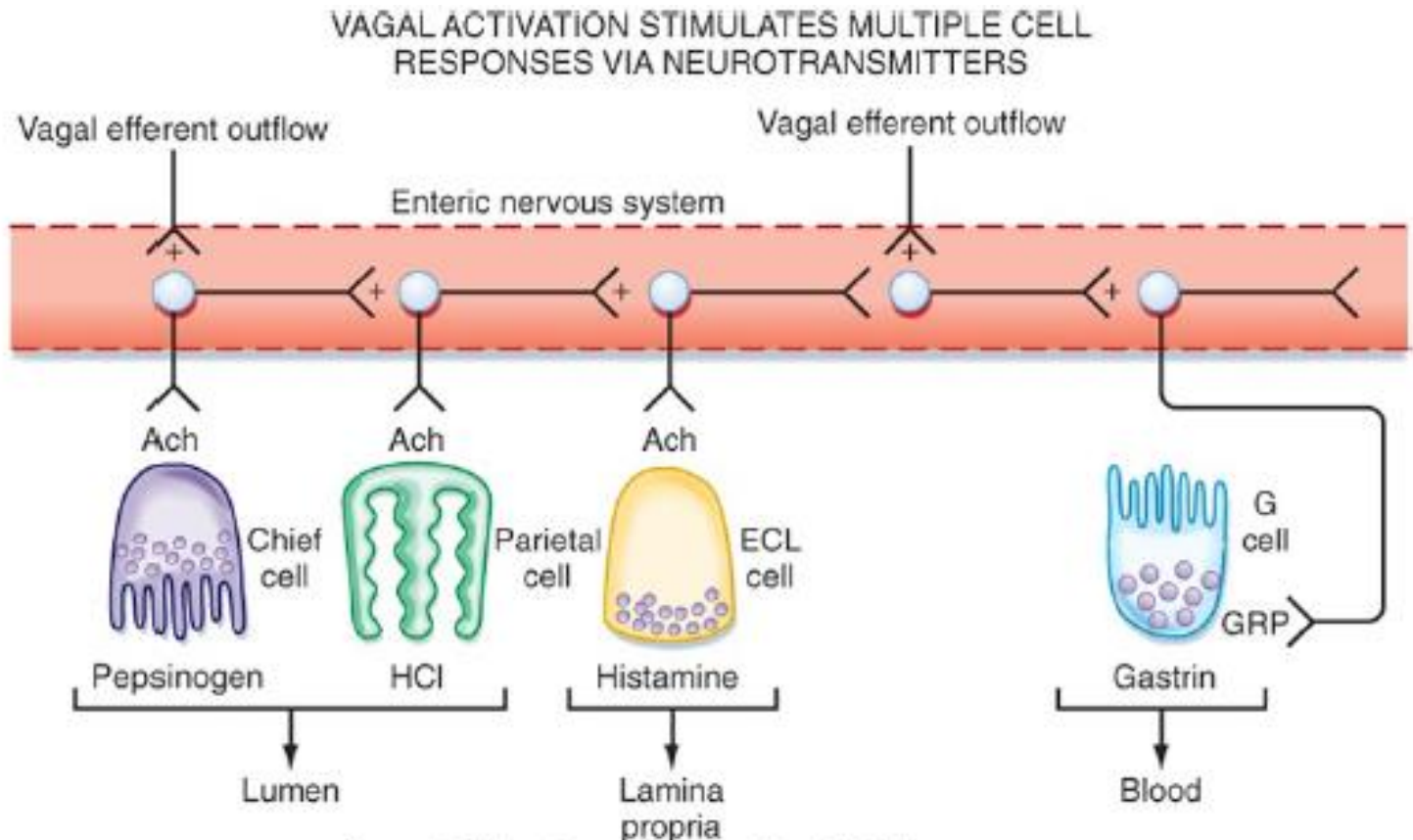
## Production & Action of Pepsin



Optimum pH for pepsin = 1.8-3.5

pH > 5 inactivates pepsin

# Vagal stimulation affects many gastric cells



Koepfen & Stanton: Berne and Levy Physiology, 6th Edition.  
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Figure 28-9 Vagal parasympathetic stimulation of gastric secretions via enteric neurons. Vagal preganglionic neurons innervate the myenteric and submucosal plexus; the terminals of the vagal preganglionic neurons innervate many enteric neurons and thus bring about changes in function as described in [Figure 28-7](#).



# Phases of Gastric Secretion

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- <https://youtu.be/ifDp57pvKOg>
- <https://youtu.be/pqgcElaXGME>

A stylized, colorful illustration of the human digestive system. It shows the esophagus (orange), liver (red), gallbladder (green), stomach (purple), and small intestine (green) within the large intestine (orange).

# Phases of Gastric Secretion

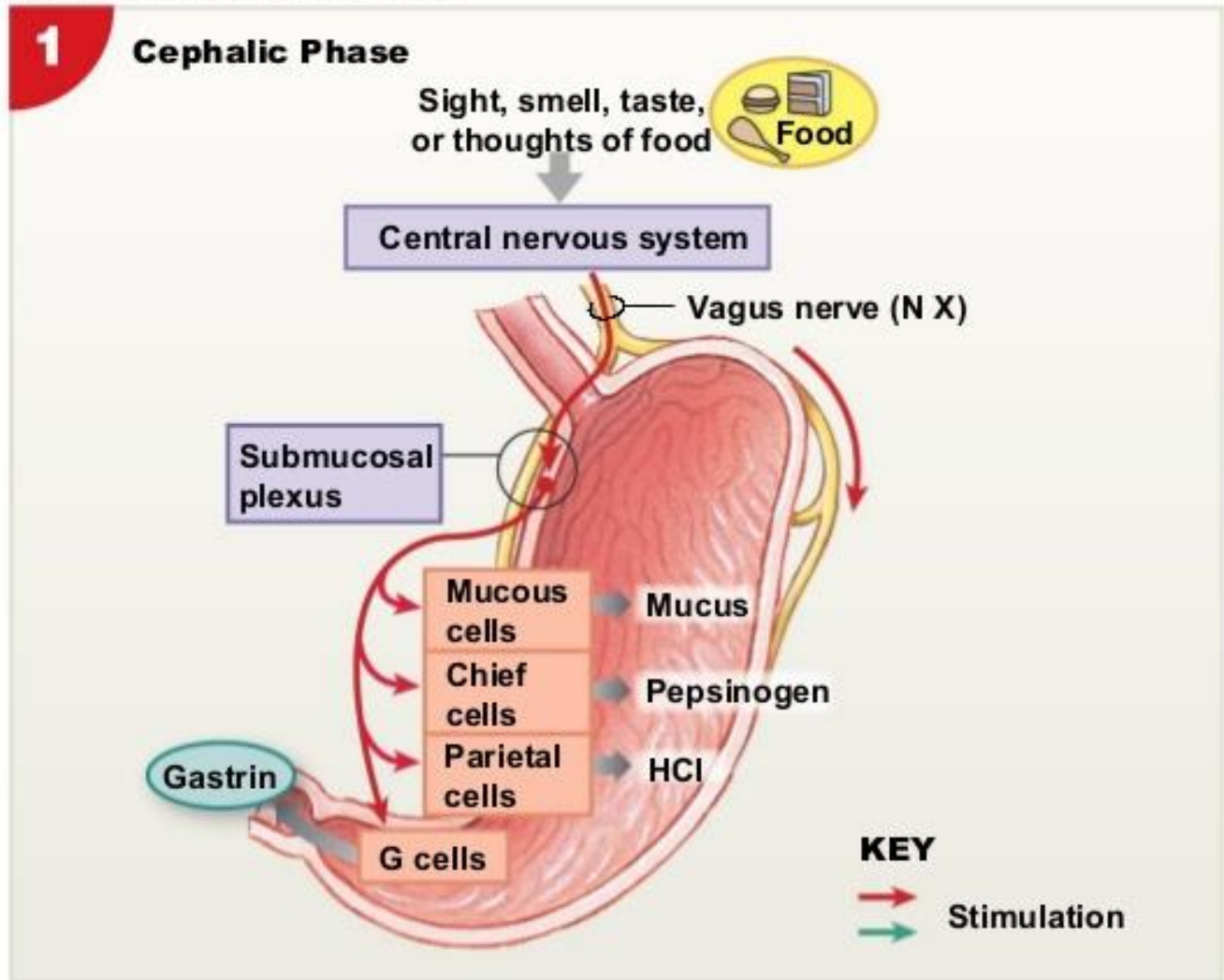
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1. ***Cephalic phase*** → Before food arrives at stomach (30% of gastric secretion).
2. ***Gastric phase*** → when food enters the stomach (60% of gastric secretion).
3. ***Intestinal phase*** → when chyme enters duodenum (10% of gastric secretion.)

# Cephalic Phase

Figure 16-9 The Phases of Gastric Secretion.

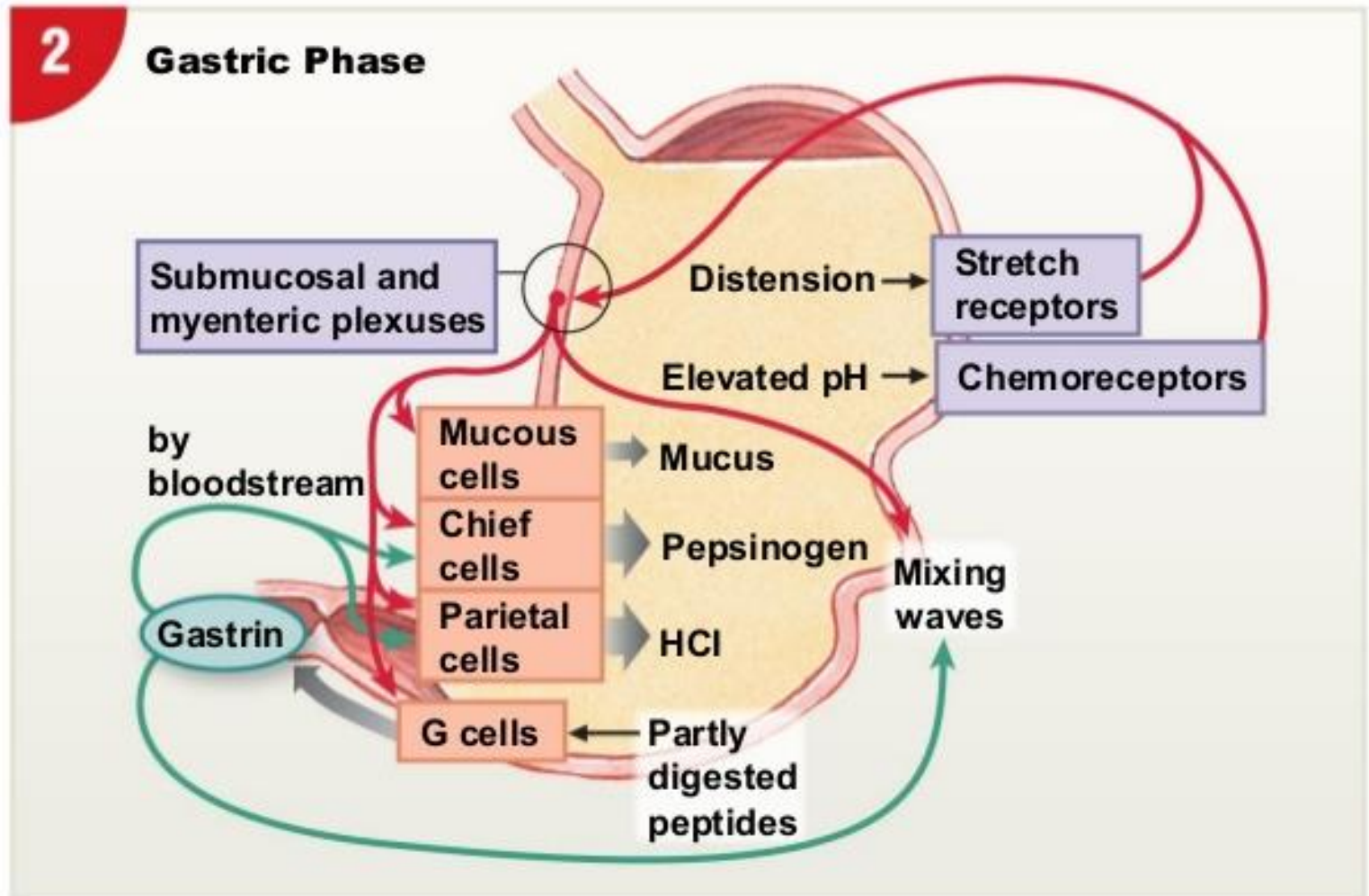
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# Gastric Phase

Figure 16-9 The Phases of Gastric Secretion.

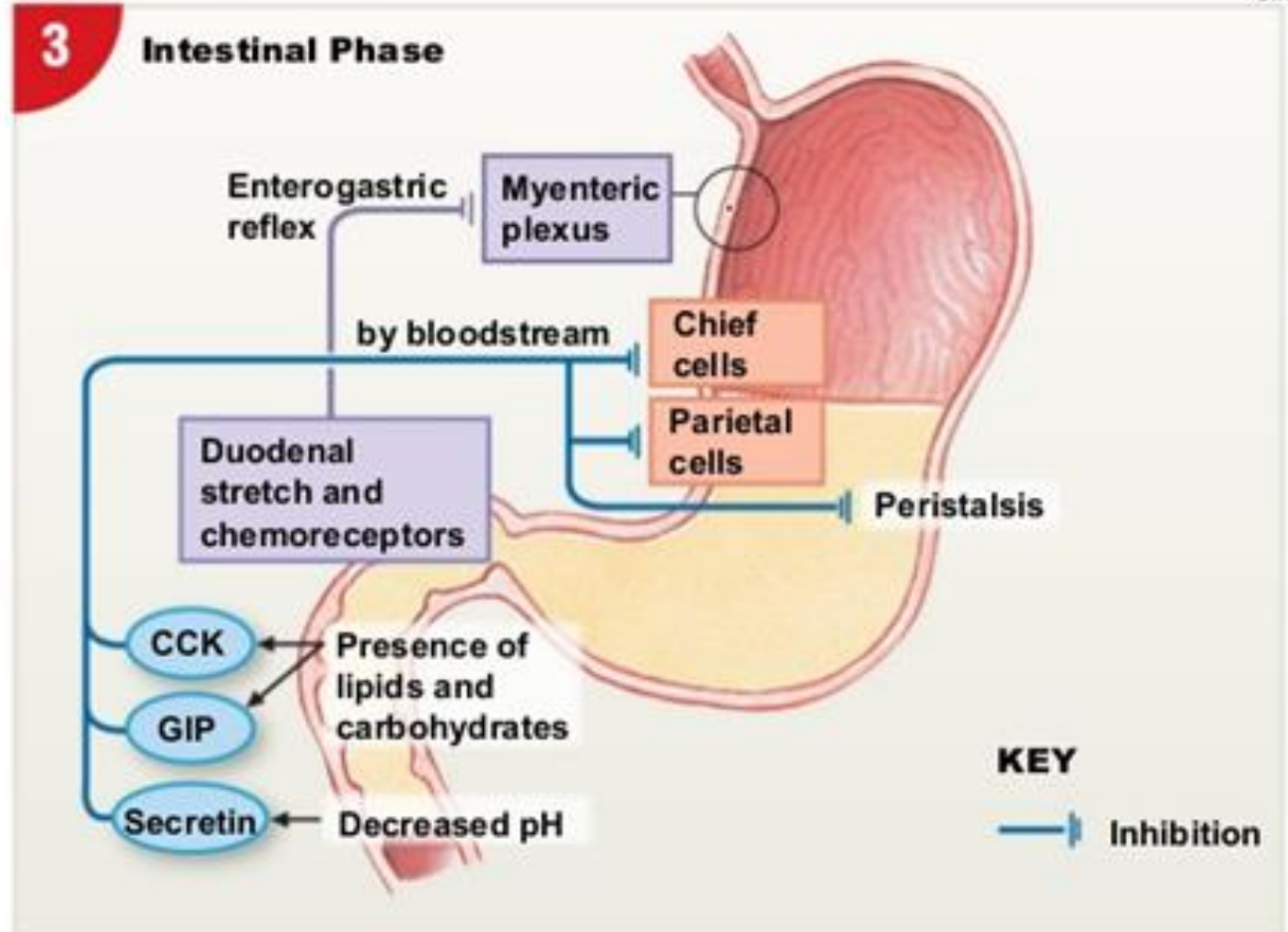
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# Intestinal Phase

Figure 16-9 The Phases of Gastric Secretion.

Slide 3





# Gastric Motility

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# Stomach Movement

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Has 3 main functions

Storage of  
food

Entrance of food  
“Vagovagal reflex”  
↓ muscular tone of the  
body of stomach  
Allowing stomach to  
accommodate food  
≈ 0.8-1.5L

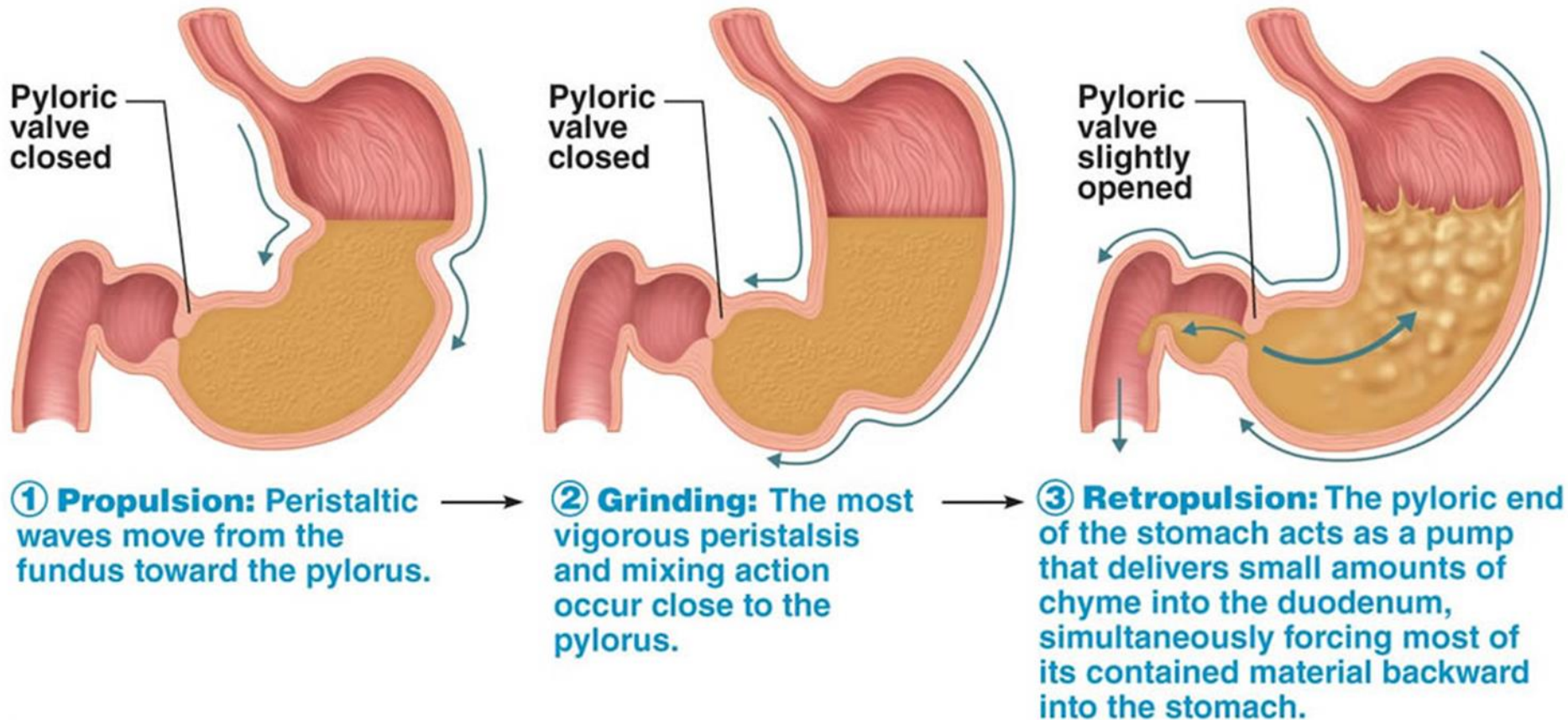
Mixing  
food

Weak peristaltic waves start  
from mid upper portion of  
stomach  
“**constrictor/mixing waves**”  
Move toward antrum  
↑ intensity  
Against a tight pylorus will  
result in “**retropulsion**”

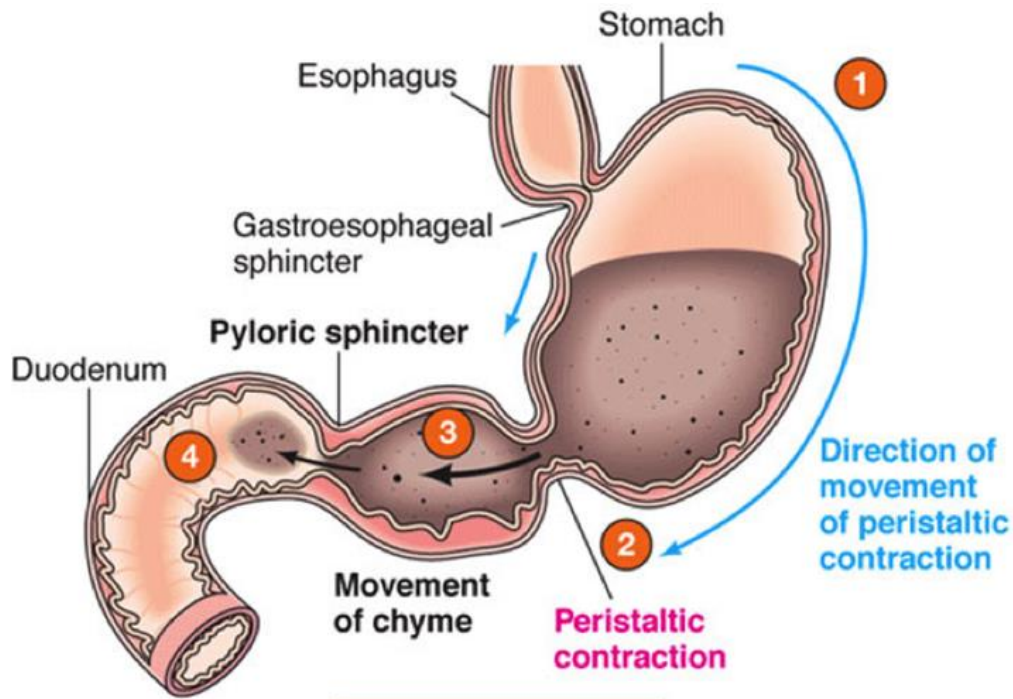
Emptying  
into  
duodenum

Movement of  
chyme into  
duodenum is  
achieved by  
“**Pyloric pump**”  
Allows < 2mm to  
pass

# Stomach Movement

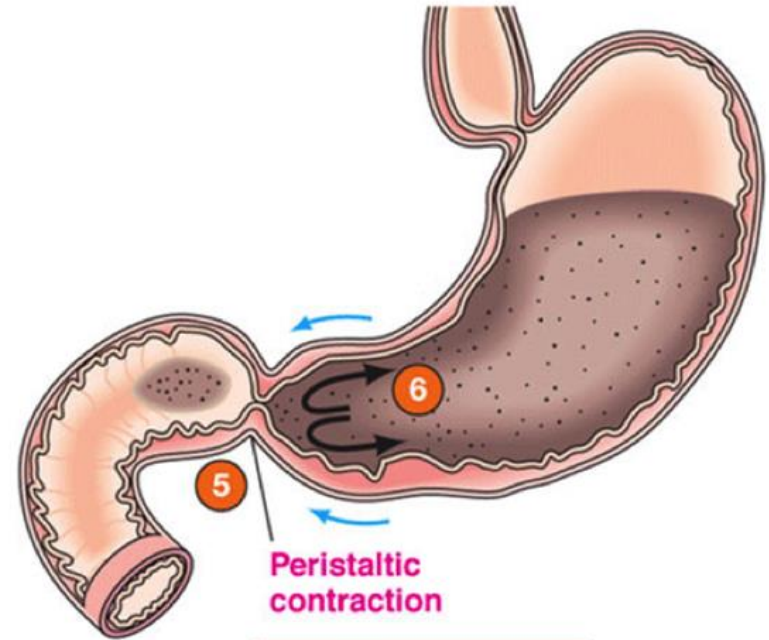






**Gastric emptying**

- 1 A peristaltic contraction originates in the upper fundus and sweeps down toward the pyloric sphincter.
- 2 The contraction becomes more vigorous as it reaches the thick-muscled antrum.
- 3 The strong antral peristaltic contraction propels the chyme forward.
- 4 A small portion of chyme is pushed through the partially open sphincter into the duodenum. The stronger the antral contraction, the more chyme is emptied with each contractile wave.



**Gastric mixing**

- 5 When the peristaltic contraction reaches the pyloric sphincter, the sphincter is tightly closed and no further emptying takes place.
- 6 When chyme that was being propelled forward hits the closed sphincter, it is tossed back into the antrum. Mixing of chyme is accomplished as chyme is propelled forward and tossed back into the antrum with each peristaltic contraction.

# Role of Pylorus

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- It is slightly tonically contracted almost all the time “**pyloric sphincter**”.
- It is usually open enough to allow water & fluids to pass.
- It is controlled by nervous and humoral reflexes from the stomach and duodenum

# Regulation of Gastric Emptying

Factors that regulate gastric emptying

Promote Emptying

Usually are *gastric factors*

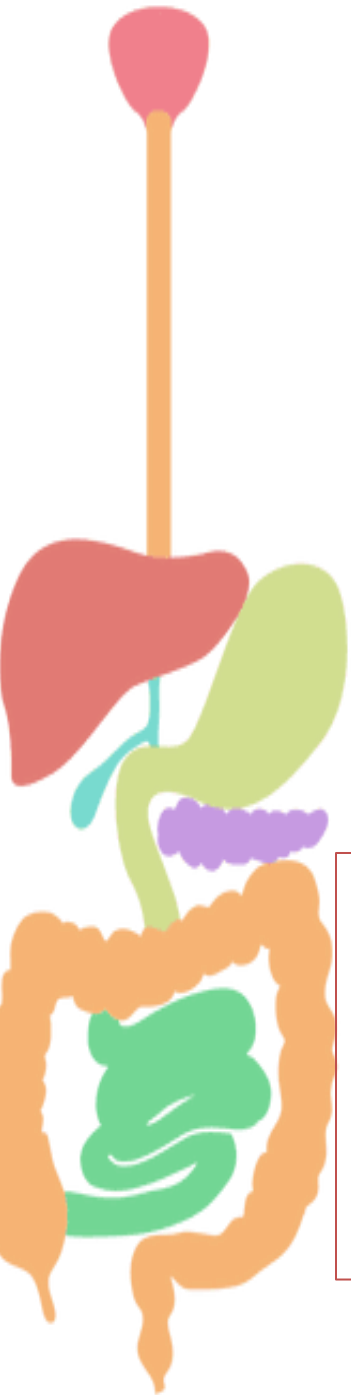
*Volume of food* → ↑ pyloric pump and inhibit pylorus.

*Gastrin* → mild to mod. ↑ pyloric pump

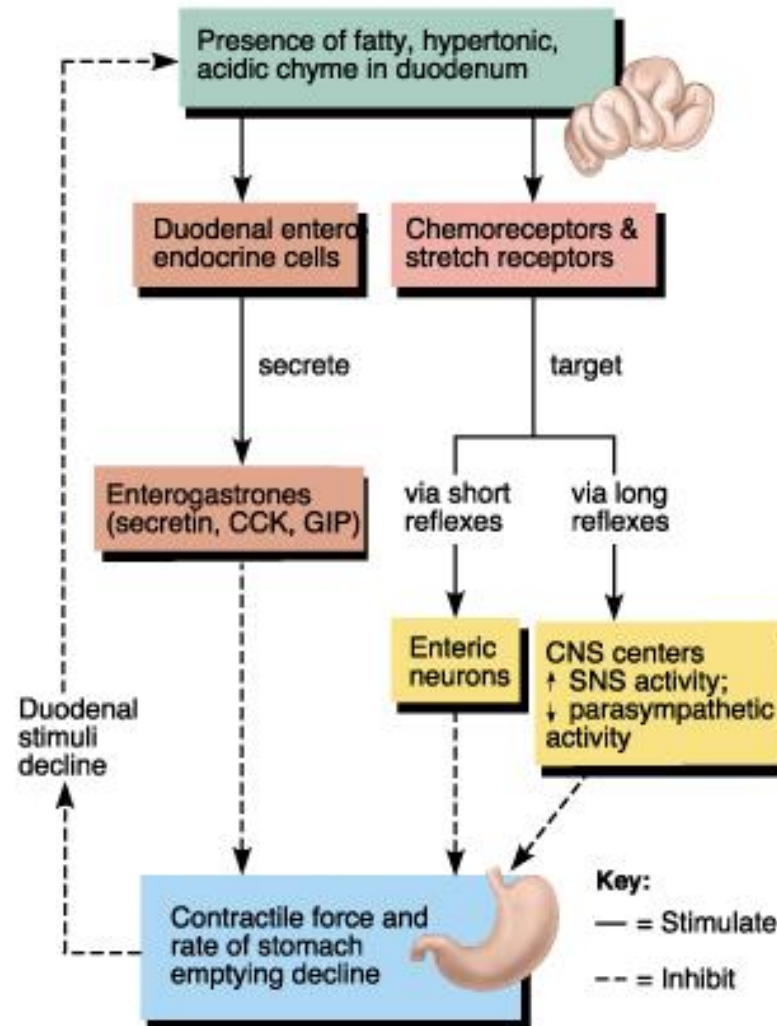
Inhibit emptying

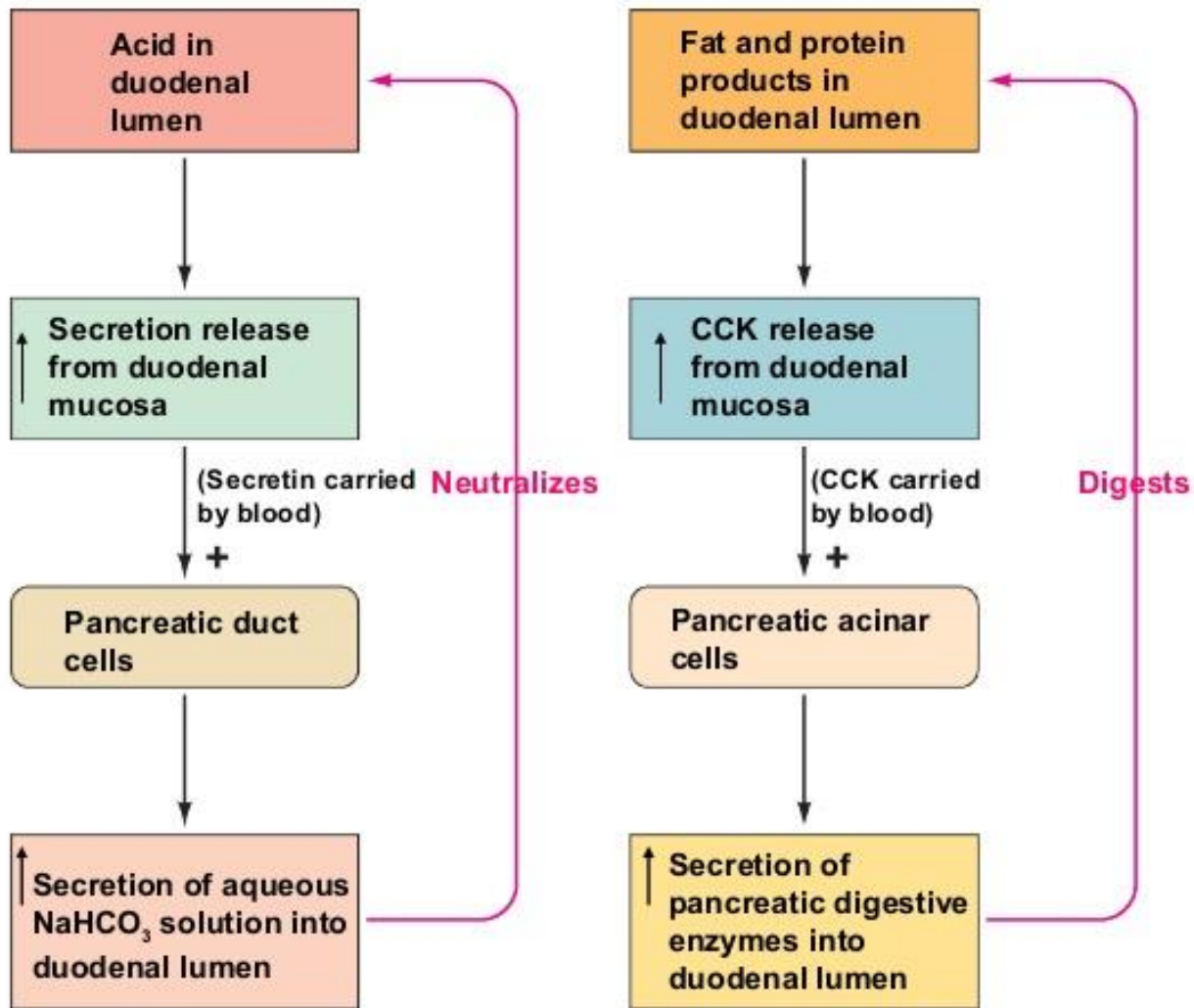
Usually are *duodenal factors*

*Neural & hormonal*



# Duodenal Control of Gastric Emptying







***What are hunger contractions?***



# **Digestion & Absorption in Stomach**

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# Digestion- Carbohydrates

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- Digestion of carbohydrate in mouth & stomach
  - Food mixed with saliva that contain ptyalin (an  $\alpha$  amylase) secreted by parotid gland.
  - It hydrolysis starch to maltose.
  - It continues in stomach for 1 hr.
  - Gastric acid deactivates it.





# Digestion-Proteins

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- Digestion of proteins in the stomach
  - Pepsin
    - secreted by chief (peptic) cells.
    - It is active at pH 2-3 and inactive at pH 5.
    - Initiate protein digestion (10-20% of protein digestion).
  - Hydrochloric acid
    - secreted by parietal (oxyntic) cells.



# Absorption

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- Stomach is a poor absorptive area of GIT
  - It lacks the villous type of absorptive membrane
  - It has tight junctions between epithelial cells
  - Only a few highly-lipid soluble substances can be absorbed such as:
    - Alcohol
    - Aspirin



