

# Digestive System

By d Gehan el wakeel

Digestion **is the breakdown of food & nutrients into smaller** particles that can **be absorbed** in the small intestine.

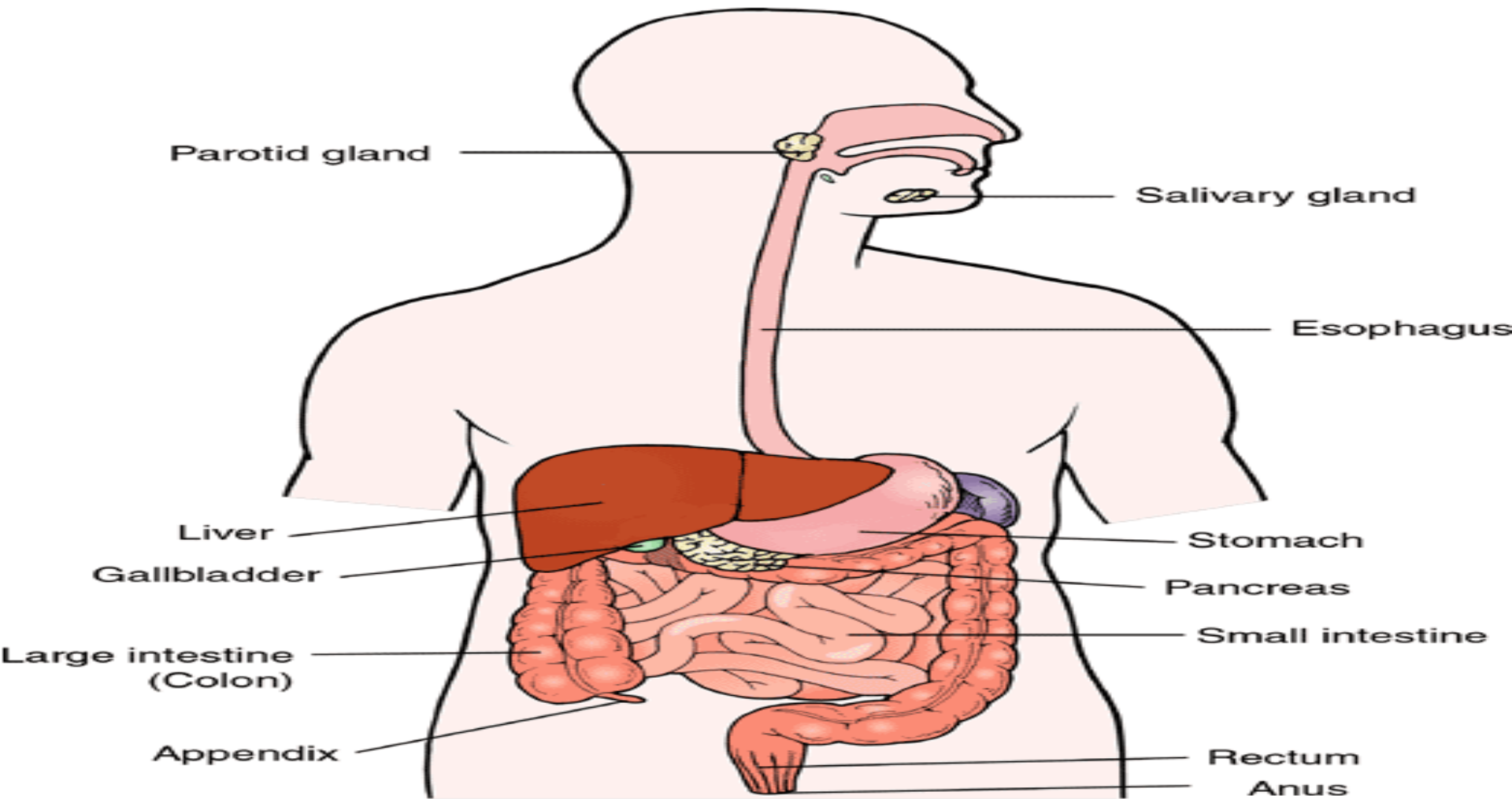
**The digestive system consists of:**

**1. Alimentary canal (gut):**

- It is a muscular tube **about 4.5 meters long extending from the mouth to the anus.**
- It consists of **buccal cavity, pharynx, esophagus, stomach, duodenum, and small and large intestine.**

**2. Digestive glands** → salivary glands, liver and pancreas.

# Digestive System



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Fig.: Digestive system

## General functions of the digestive system

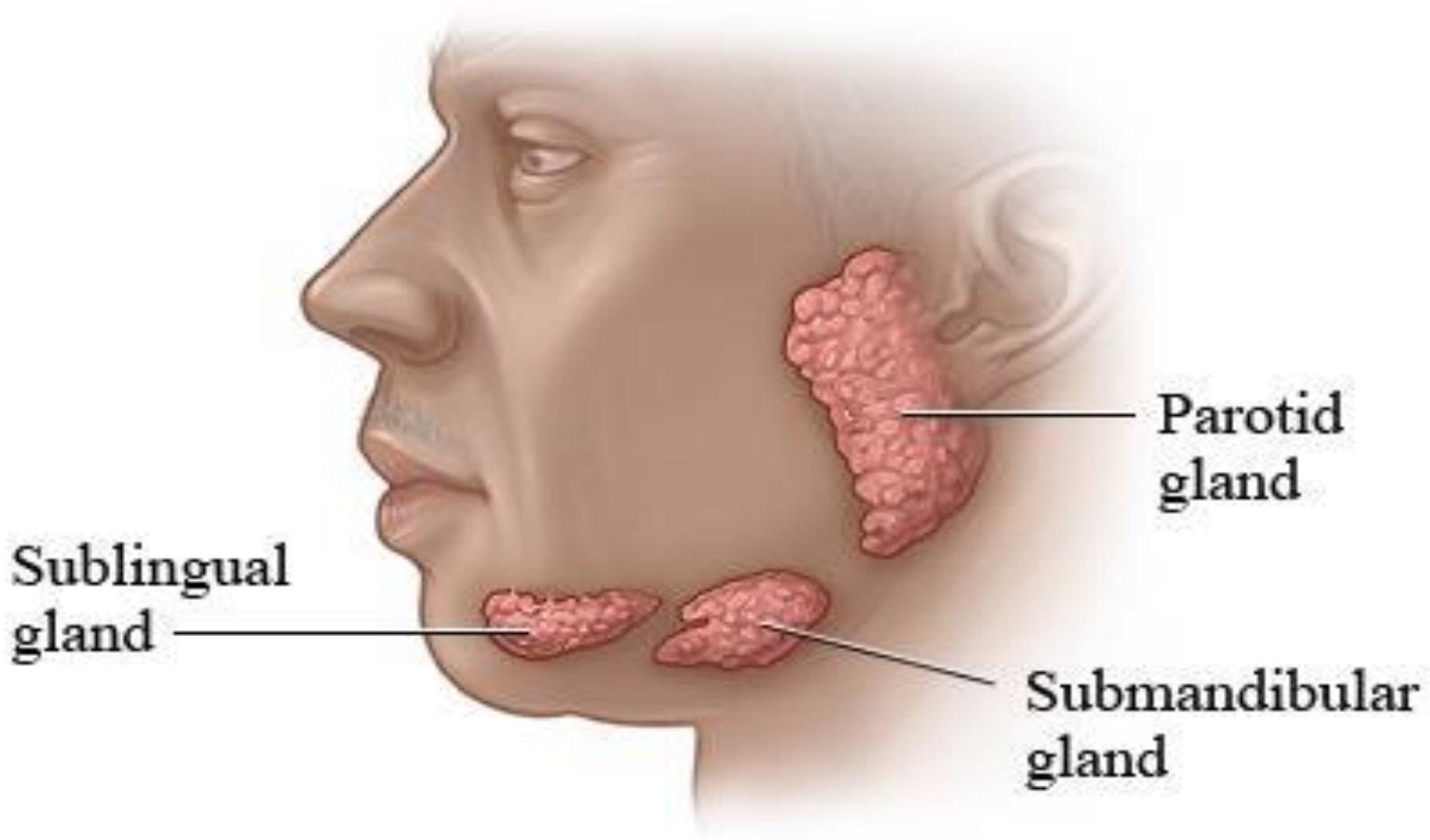
1. Motility
2. **Secretion of digestive juices**
3. Digestion of food
4. **Absorption**

# Salivary Secretion

**Principal Salivary Glands: Parotid, submandibular and sublingual glands.**

## **b) Histology:**

- Each gland is formed of **group of secretory acini called salivons.**
- The salivons **consists of acinus and ducts**
- The acinar cells include 2 types;
  - a. **Serous cells** which secrete **watery secretion rich in amylase enzyme**
  - b. **Mucous cells** **which secrete viscid secretion rich in mucin**

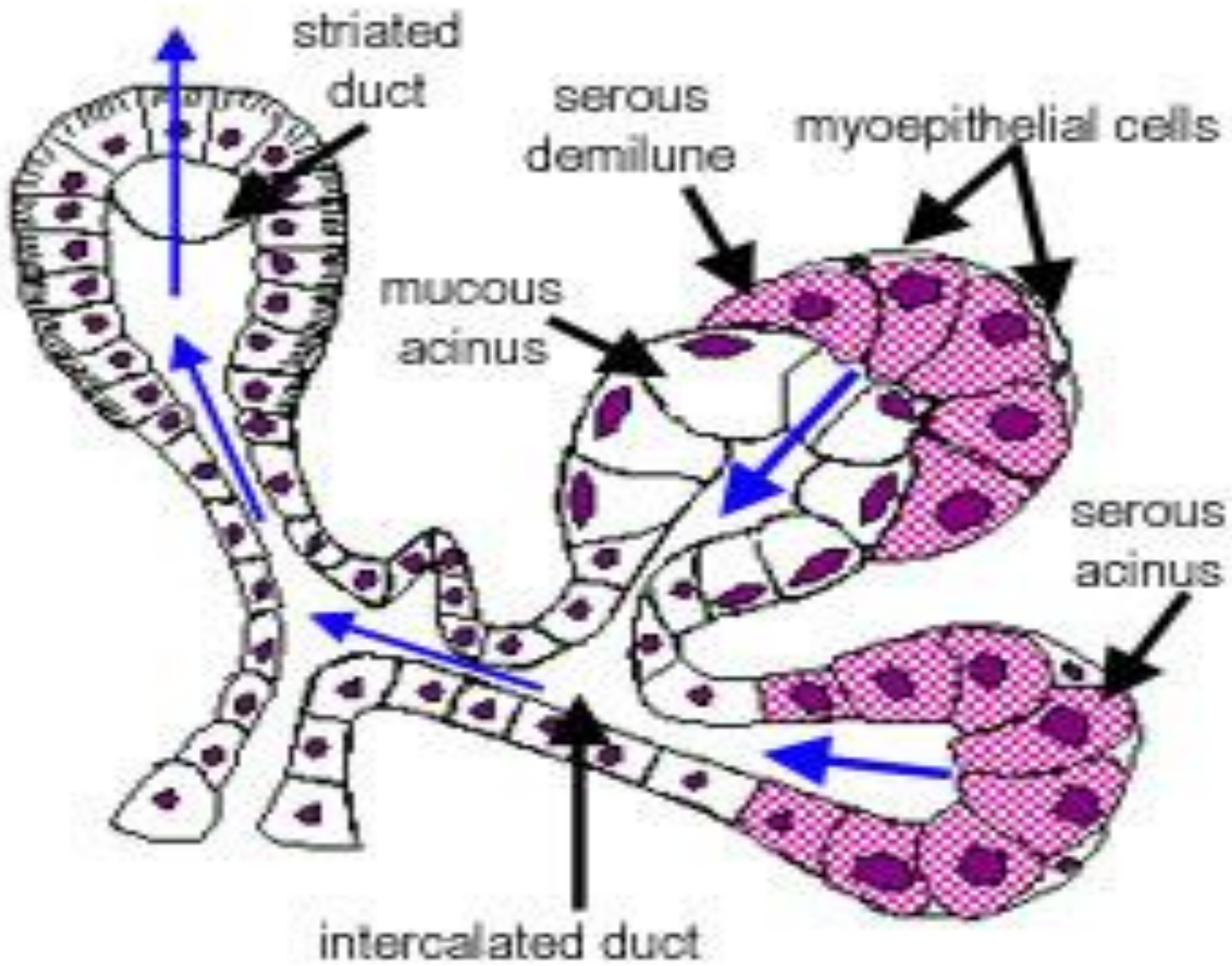


Sublingual  
gland

Parotid  
gland

Submandibular  
gland

**Fig. :** Salivary Glands



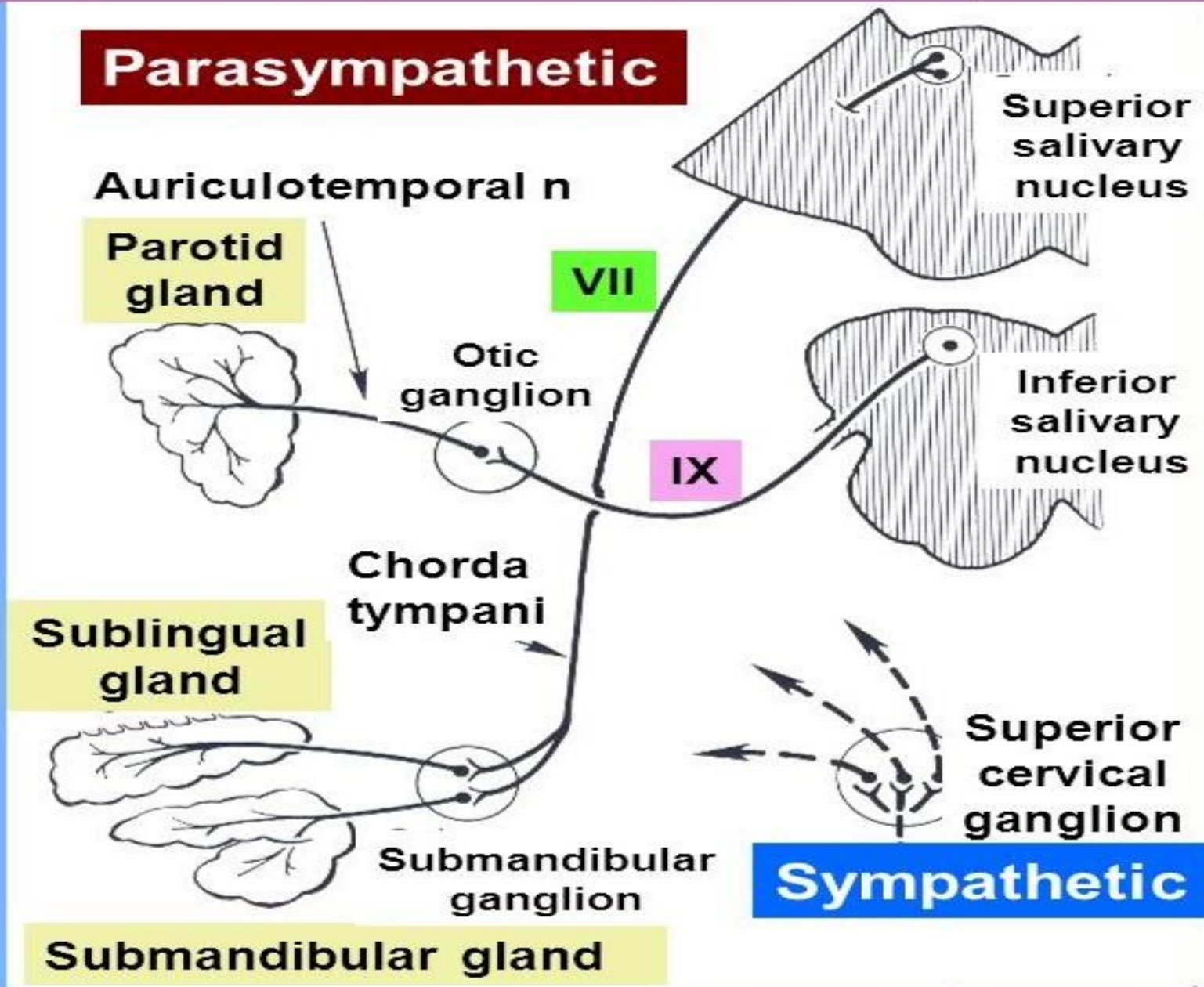
## d) Innervation of salivary glands:

The salivary glands are innervated by sympathetic and parasympathetic nerve

	Sympathetic Supply	Parasympathetic Supply
Origin	<b>LHCs of T1 and T2</b>	-Facial nerve → <b>submandibular and sublingual glands</b> - <b>Glossopharyngeal nerve</b> → <b>parotid</b>
Functions	1-Trophic secretion: <b>is small in volume and rich in enzymes and mucin.</b> <b>2-Vasoconstriction.</b>	<b>1-True secretion: is large in volume, watery in consistency &amp; rich in electrolytes</b> <b>2-Marked vasodilatation (V.D.)</b>



# Innervation of salivary gland



# Saliva

**Saliva Volume:**

**800-1500**

**ml/day. Composition:** Saliva is composed of:

**1. 99.5 % water**

**2. 0.5 % solids; are:**

- Inorganic: Na, K, Cl & HCO<sub>3</sub> which act as buffers and activators.**

**a) Organic:**

**- Enzymes:**

- Digestive enzymes ( $\alpha$ -amylase and lingual lipase).**

- Lysozyme which attacks walls of the bacteria.**

  - Mucin.**

  - IgA.**

# Functions of Saliva

- 1-Digestion:** It contains  **$\alpha$ -amylase enzyme** which starts the **digestion of the starches.**
- 2-Deglutition:** It contains **mucin** which acts a **lubricant to facilitate swallowing.**
- 3-Diluting medium:** It acts as a diluting medium for irritating substances.
- 4-Speech:** It keeps the **buccal cavity wet; which aids speech by facilitating movements of lips and tongue.**
- 5-Solvent:** It acts as solvent for food particles **to be an effective stimulus to taste receptors.**

## 6-Buffering action:

- It **keeps the PH of the mouth about 7.**
- This alkalinity preserves calcium in the teeth.
- Acidity of the buccal cavity (e.g. by bacterial action on food remnants) will cause dissolving of Ca from teeth.
- Loss of Ca from teeth will lead to dental caries.

## 7. Oral hygiene:

- a. **The flow of saliva washes away the pathogenic bacteria.**
- b. Saliva contains IgA which defends against bacteria and viruses.
- c. **Thiocyanate ions which are bactericidal.**
- d. Lysozyme

# Mastication (Chewing)

## Definition

- It is the act **by which food is broken down to small particles to be swallowed easily**
- It involves movements of the mandible, lips, cheeks and tongue.
- Teeth grind and break down food.

## Functions of Mastication:

1. Breakdown of the food into small particles to be easily swallowed
2. Chewing is important for digestion **of all types of food, but it is especially important for digestion of fruits and raw vegetables.**

# Deglutition (Swallowing)

**Definition** - It is the act of transfer of food from the mouth cavity to the stomach.

## **Phases:**

- It is divided into three stages (phases).

### **A) Buccal (voluntary) stage:**

- During it, **the food is pushed into the pharynx by the tongue.**
- **It is done by the upward and backward movement of the tongue**

## **B) Pharyngeal (involuntary) stage:**

- It takes 1- 2 seconds
- **Presence of food in the back of the mouth → stimulate swallowing receptor in pharynx → which causes;**
  - a) Closure of the posterior nasal opening by soft palate
  - b) Closure of the laryngeal opening by vocal cords and epiglottis.**
  - c) Stop of breathing during swallowing.
  - d) Relaxation of the upper esophageal sphincter → the food moves to the esophagus.**
  - e) Relaxation of the lower esophageal sphincter and stomach to receive the food**

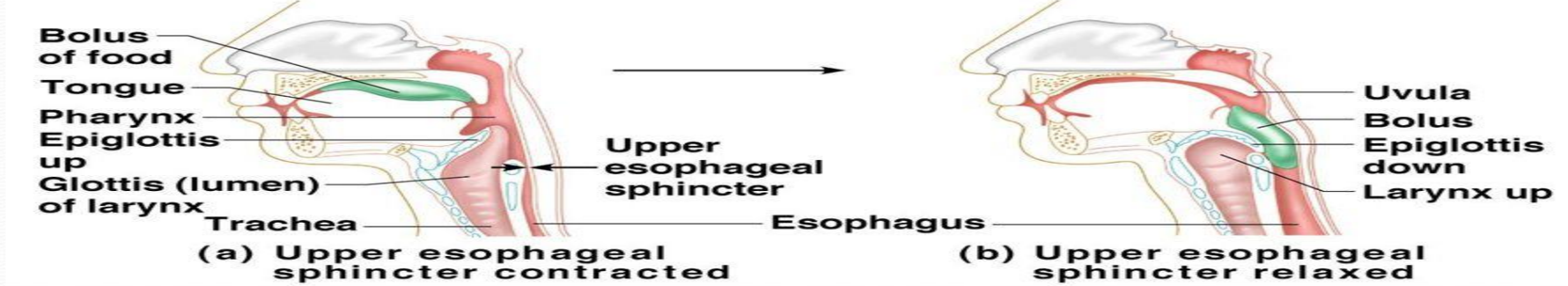


Figure 14.14a–b

## C) Esophageal Stage (Motor function of esophagus):

- It takes 8- 10 seconds
- **The food move into esophagus by peristalsis**





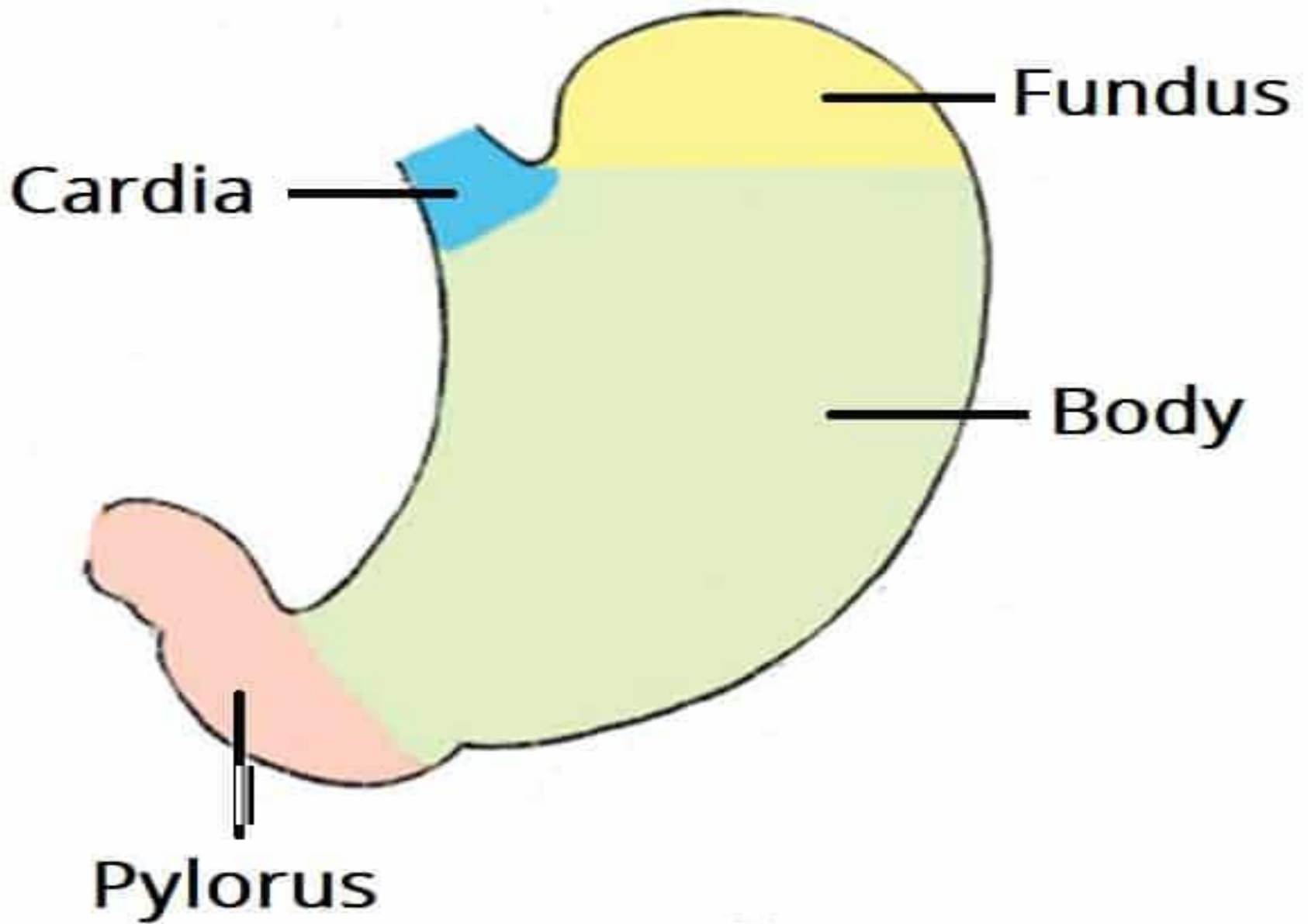
# Stomach

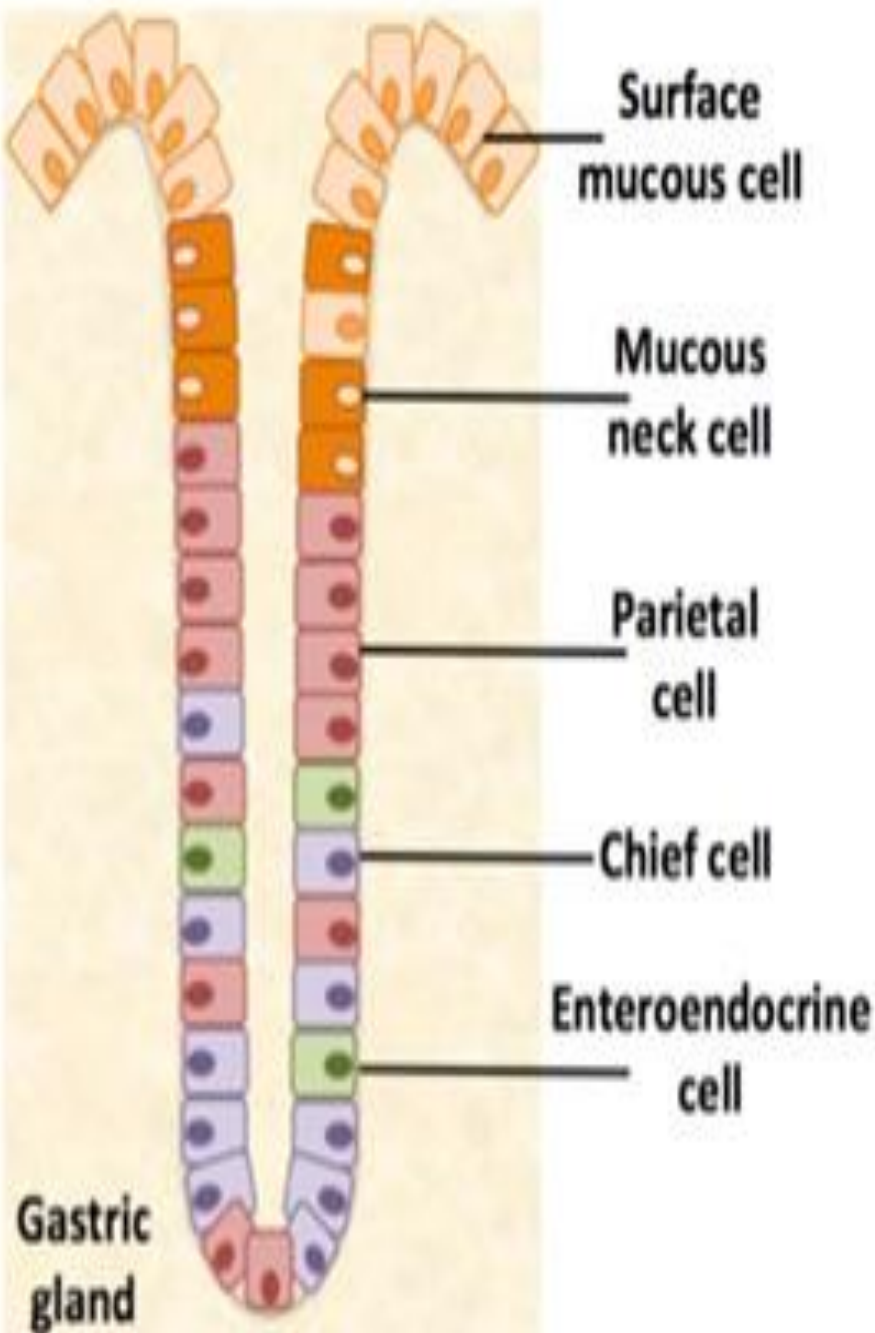
## Anatomy

- The stomach is formed of 3 parts: **fundus, body and antrum or pylorus.**

## Gastric Glands:

- The gastric mucosa contain three types of cells
  - a. **Parietal (oxyntic) cells** → **secrete HCl and intrinsic factor.**
  - b. **Peptic (chief) cells** → secrete proteolytic enzymes pepsinogens.
  - c. **Mucous cells** → **secrete mucous.**





Cells of the gastric glands	Secretory products
Surface mucous cells	Mucin in an alkaline fluid
Mucous neck cells	Mucin in an acidic fluid
Parietal cells	HCl & intrinsic factor
Chief cells	Pepsinogen & lipase
G cells/enteroendocrine cells	Gastrin

# Nerve supply:

## A) Sympathetic supply

- 1- causes **relaxation of the wall of the stomach and contraction of pyloric sphincter** → delayed emptying
- 2- Stimulate mucous secretion.
- 3- **V.C. of gastric blood vessels.**

## B) Parasympathetic supply

- 1- Causes contraction of the wall of the stomach and relaxation of pyloric sphincter → rapid emptying.
- 2- stimulate secretion of HCL and pepsin
- 3- **V.D. of gastric blood vessels.**

# Gastric Juice

- PH is 1 → **the most acidic fluid in the body.**
- The volume is 3 L/day.

**Composition:** a. Water 99%. b. HCl 0.5%

- Inorganic constituents → 0.1%. e.g. Na, K, Ca, Mg.**
- Organic constituents → 0.4%. e.g.**
  - Enzymes: **pepsinogens, gastric lipase, gelatinase and gastric amylase.**
  - Mucous.
  - **Intrinsic factor.**

## Functions of HCL

1. It **activates pepsinogens into pepsin** and provides the acidic medium needed for their actions.
2. **It kills many ingested bacteria.**
3. It helps Ca and iron absorption.
4. **Together with pepsin, it helps milk clotting.**

## Pepsin functions

- The active pepsin **is a proteolytic enzyme which acts on polypeptides to form peptides and peptones.**
- It needs a highly acidic medium.

## **Intrinsic Factor**

- **It is secreted by the oxyntic cells.**
- It is essential for absorption of vitamin B12.
- **Vitamin B12 is essential for maturation of RBCs, so lack of intrinsic factor causes pernicious anaemia**

## **Mucous Secretion**

- a) Is important for lubrication & mixing chime
- b) **Form a gel coat that protect the gastric mucosa from HCl & mechanical erosion by food**



# H<sup>+</sup> HCl (hydrochloric acid)

## Source :

The **parietal (oxyntic) cells**, which is characterized by :

- Presence of large number of mitochondria
- Presence of system of canaliculi

**Their surface contain 5 types of receptors**

	Acts by	Stimulated by	Inhibited by	Effect
<b>1- Muscarinic R.</b>	↑ <b>intracellular Ca<sup>++</sup></b>	<b>Acetyl choline</b>	Atropine	↑ HCl
<b>2- Gastric R</b>	↑ intracellular Ca <sup>++</sup>	Gastrin	Somatostatin	↑ HCl
<b>3- Histamine R</b>	↑ ing C-AMP	<b>Histamine</b>	<b>Somatostatin</b>	↑ HCl
<b>4- Prostaglandins</b>	↓ ing C-AMP	PGS	<b>Anti-inflammatory drugs</b>	↓ HCl
<b>5- Somatostatin</b>	↓ <b>ing C-AMP</b>	Somatostatin		↓ HCl

## N.B

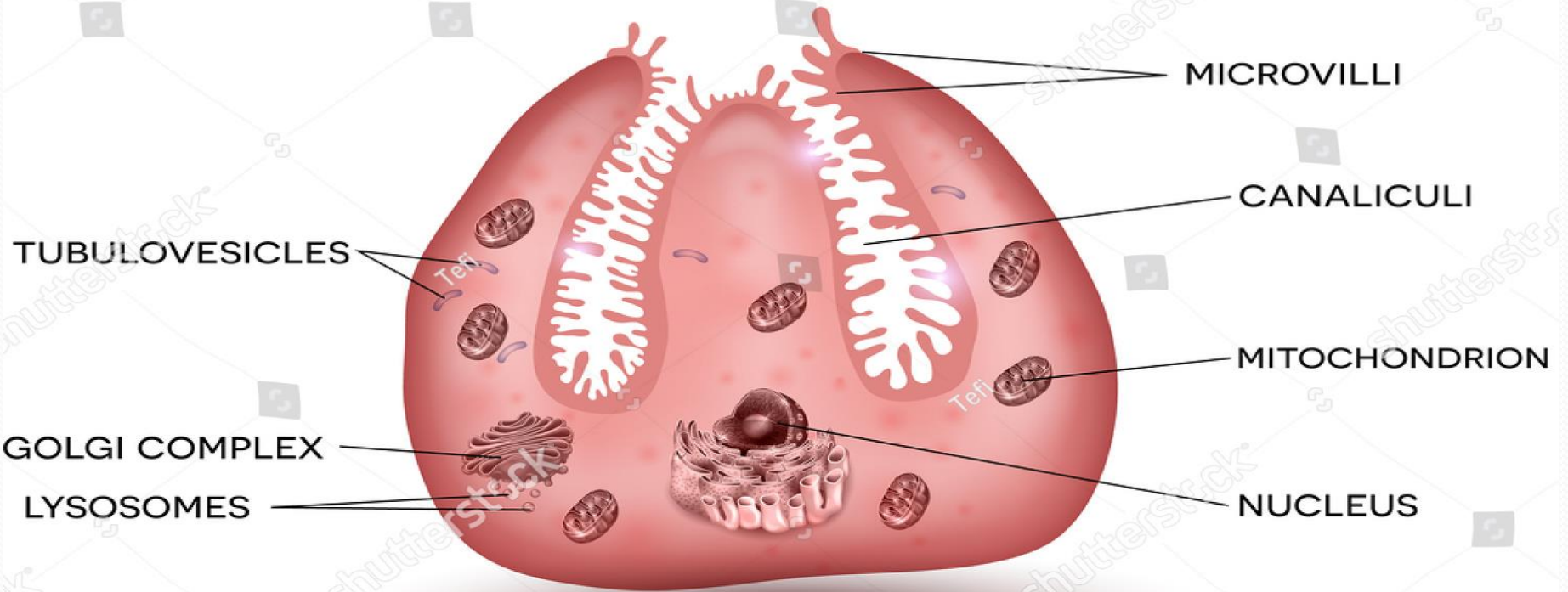
- Patients taking anti-inflammatory drugs complain of hyperacidity and peptic ulcer because these drugs  $\downarrow$  PGS  $\rightarrow$   $\uparrow$  HCl.

## Cellular mechanism for HCL secretion

1. **Cl<sup>-</sup> is actively secreted into the lumen, this creates -ve potential**
2. **K<sup>+</sup>** then diffuses to the lumen **attracted by** the -ve potential
3. **H<sup>+</sup> is pumped into the lumen in exchange with K<sup>+</sup> through the H<sup>+</sup>-K<sup>+</sup> pump (proton pump).**
4. **HCO<sub>3</sub>** then diffuses to the extracellular fluid causing **temporal alkalosis** (alkaline tide).
5. **Water then diffuses to the lumen by osmosis**

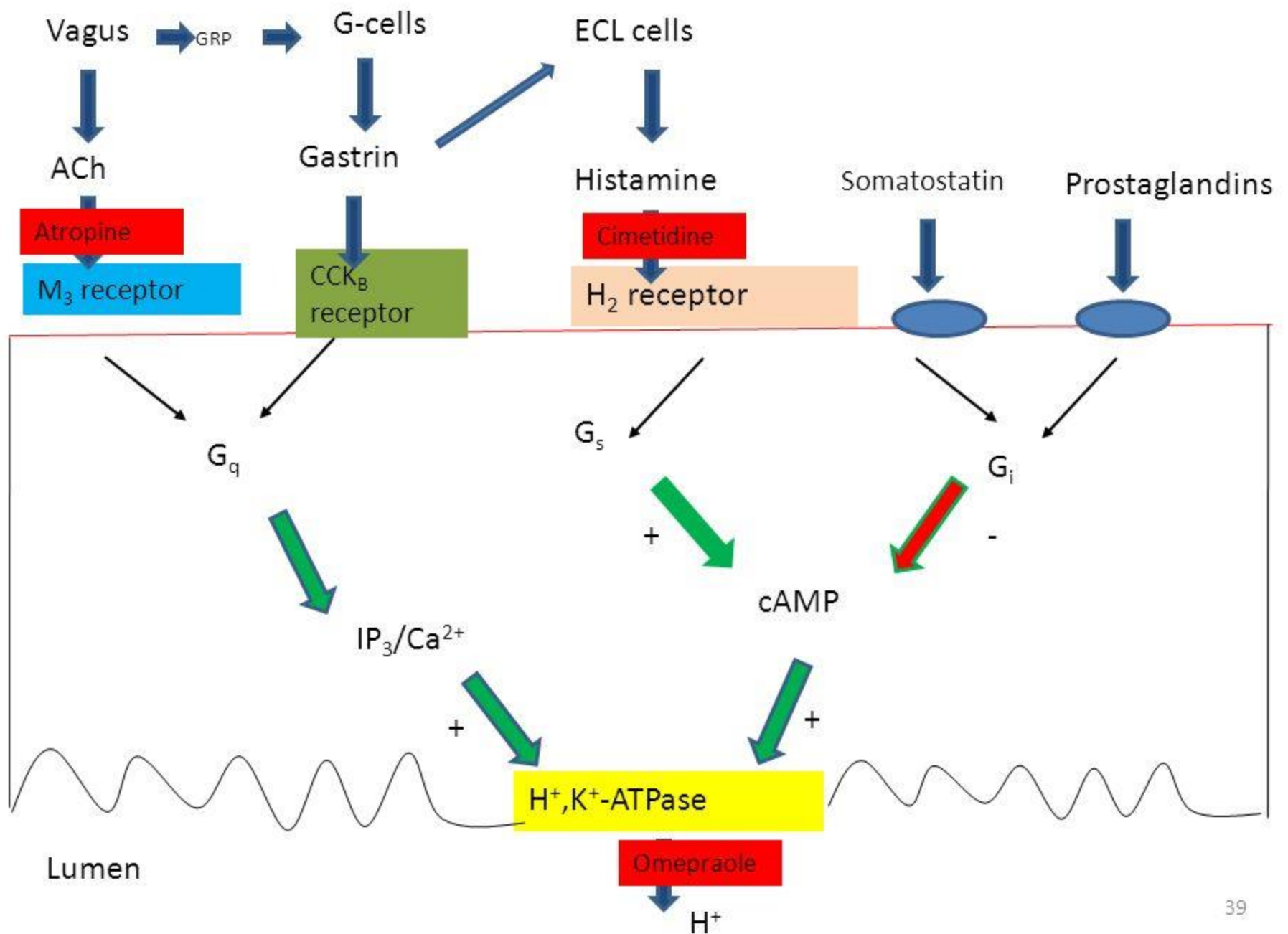
# PARIETAL CELL

CELL TYPE OF THE STOMACH WALL

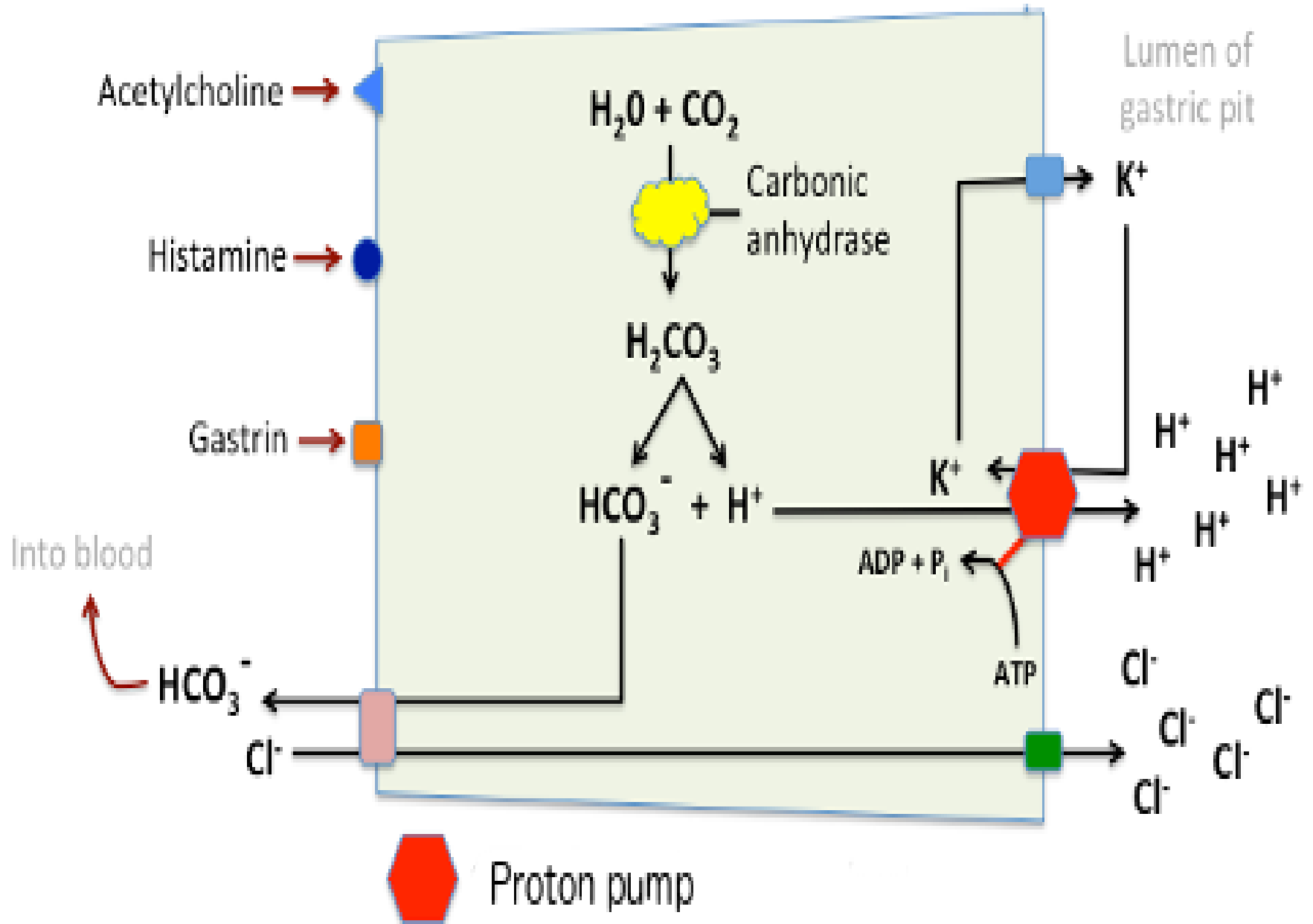




# Control of H<sup>+</sup> secretion by gastric parietal cells



# Parietal Cell



# Control of HCl secretion

## a) Stimulators

1. Acetylcholine
- 2. Histamine**
3. Gastrin
- 4. Anger & hostility**

## b) Inhibitors

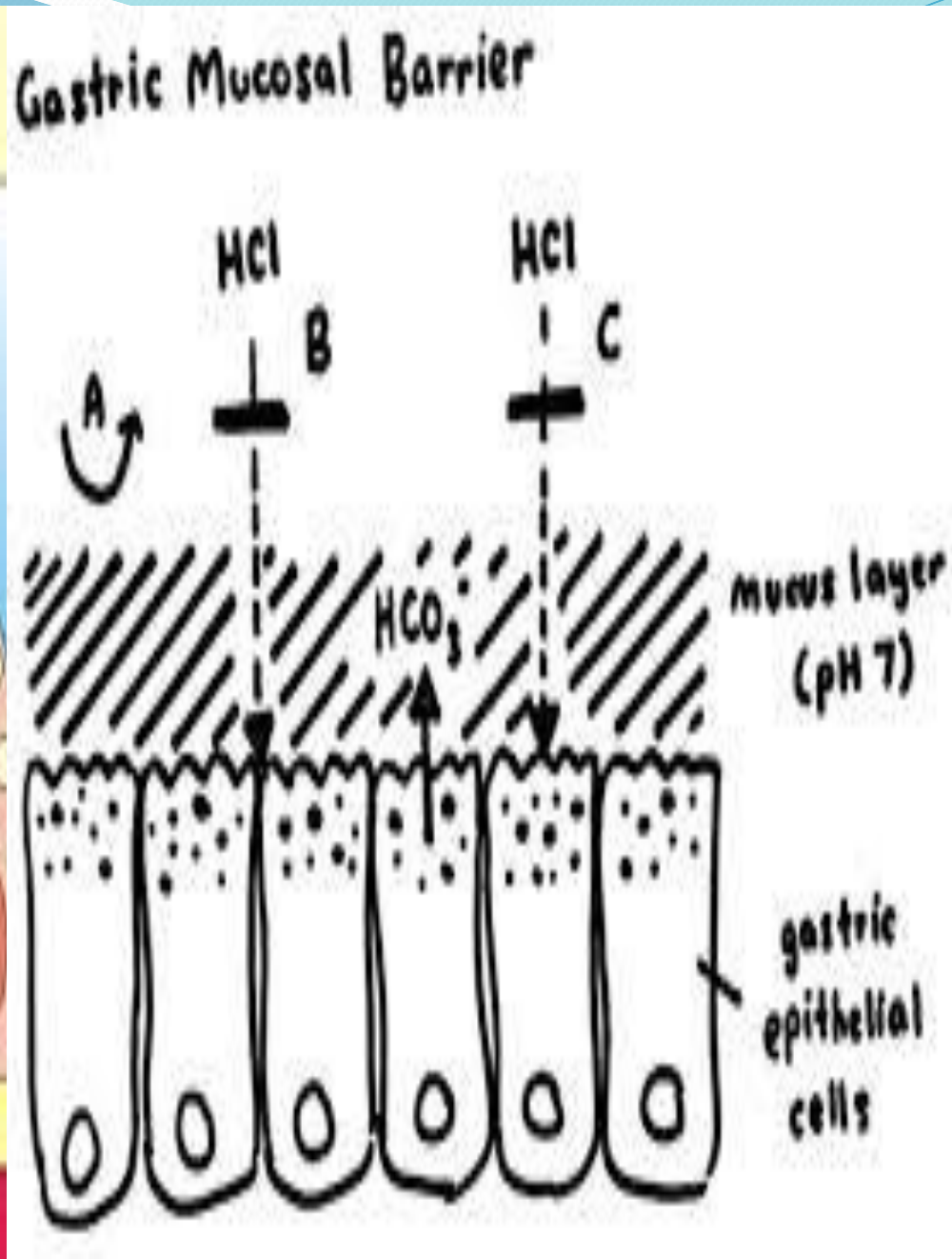
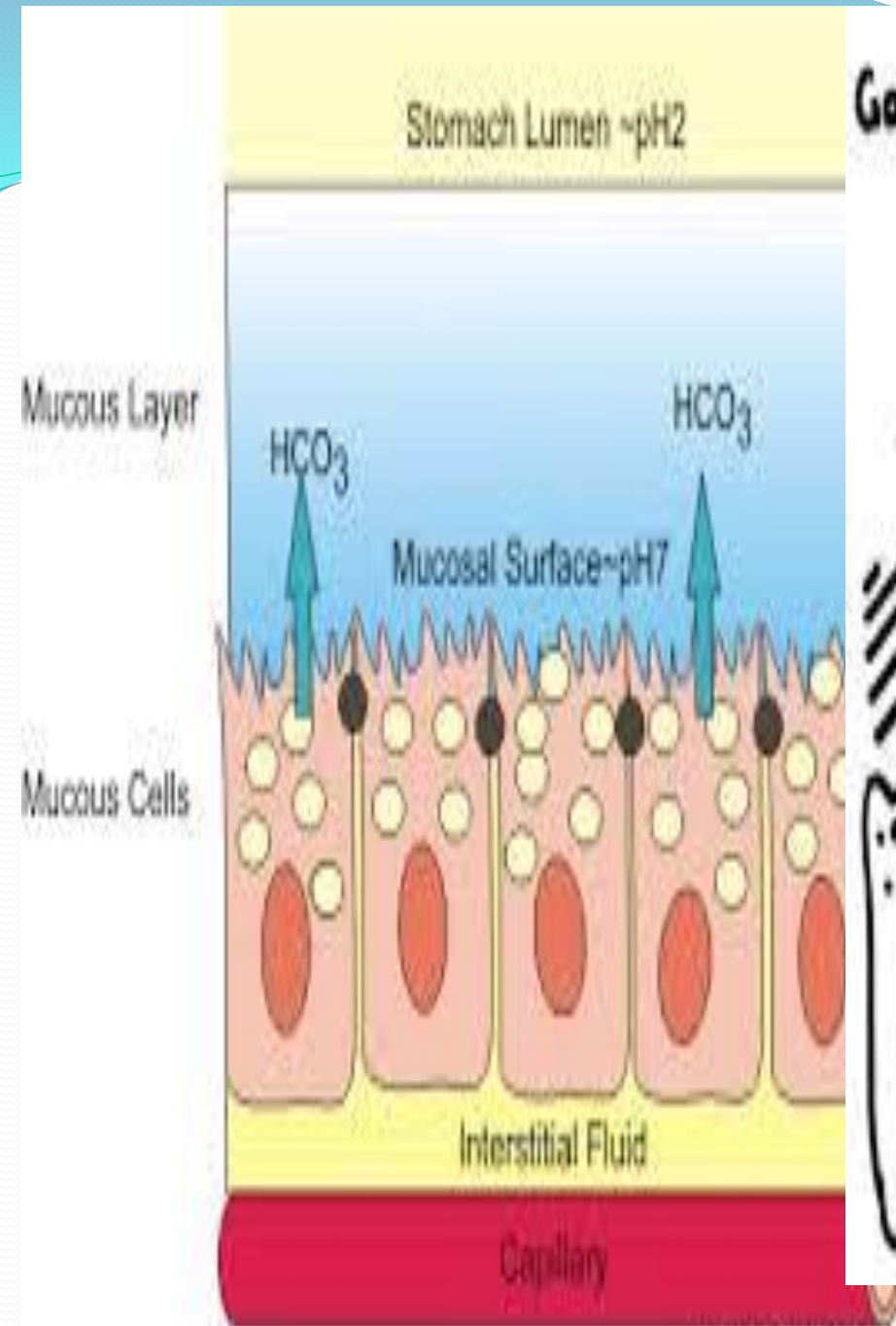
- 1. PGS**
2. ↑ acidity in the stomach
- 3. Somatostatin, GIP, VIP**
4. Fear & depression

## Functions of HCl

1. **Activate pepsinogens** into pepsins.
2. **Provide the acidic medium needed for the activity of pepsins.**
3. Kills the ingested bacteria
4. **Help iron &  $Ca^{++}$  absorption**
5. Help **milk clotting**.
6. **Controls** the rate of gastric **emptying** so that  $\uparrow$  duodenal acidity  $\rightarrow$   $\downarrow$  emptying.
7. **Stimulates bile flow & pancreatic juice by increasing CCK & secretin.**



# Gastric Mucosal Barrier



## COMPONENTS OF GASTRIC MUCOSAL BARRIER

- ⊕ A compact epithelial cell lining
- ⊕ A special mucous covering
- ⊕ Impermeability of luminal membrane of the gastric mucosal cells to hydrogen ions
- ⊕ Rapid replacement of entire stomach lining

# Digestive Systems

- Functions of digestive system:

- Accessory organs

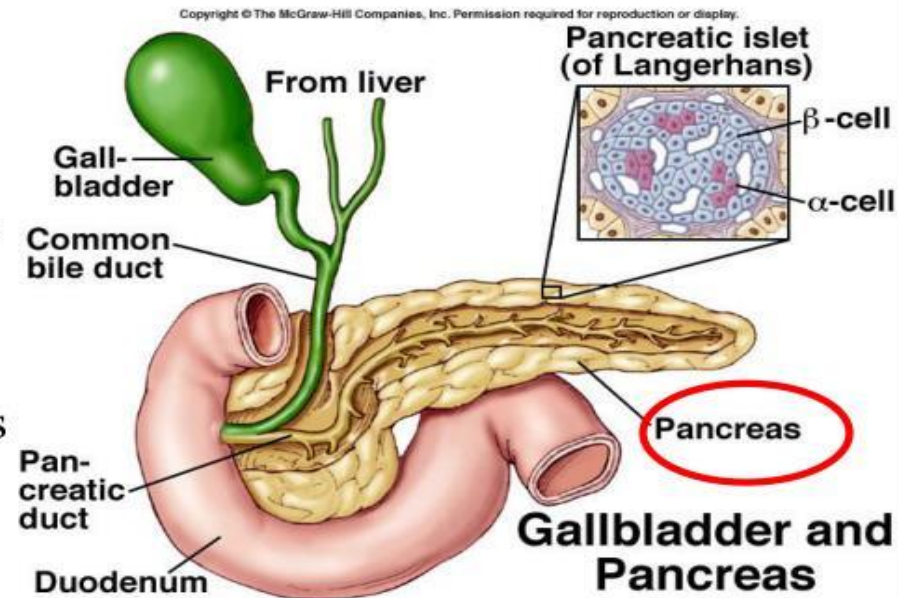
- Pancreas

- Exocrine gland between stomach and small intestine
- Produces several digestive enzymes:

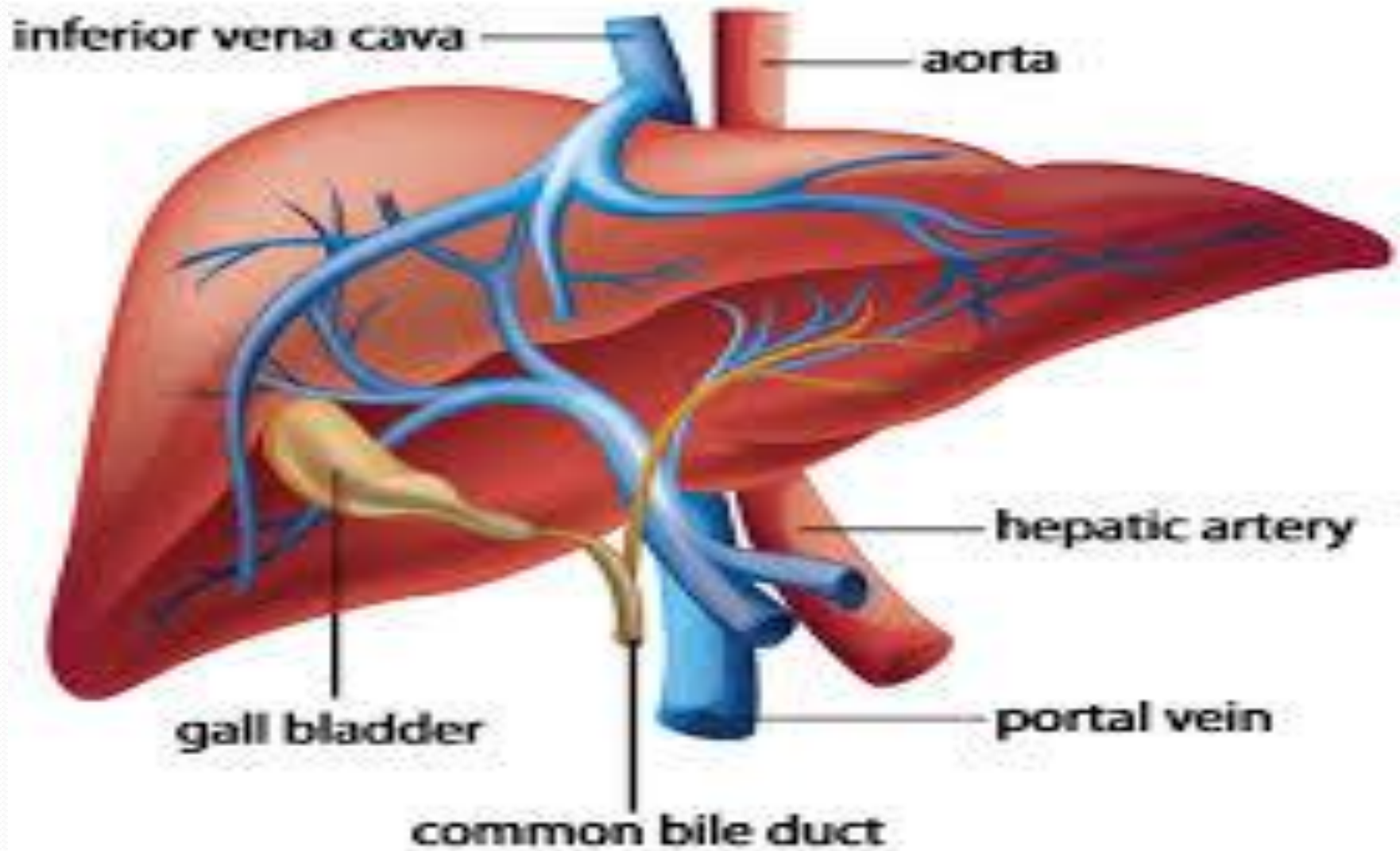
- » trypsin: digests proteins
- » pancreatic amylase: digests starches
- » lipase: digests fats

- Also acts as endocrine gland

- » produces hormones to regulate glucose levels in blood (insulin and glucagon)



# Human Liver Anatomy



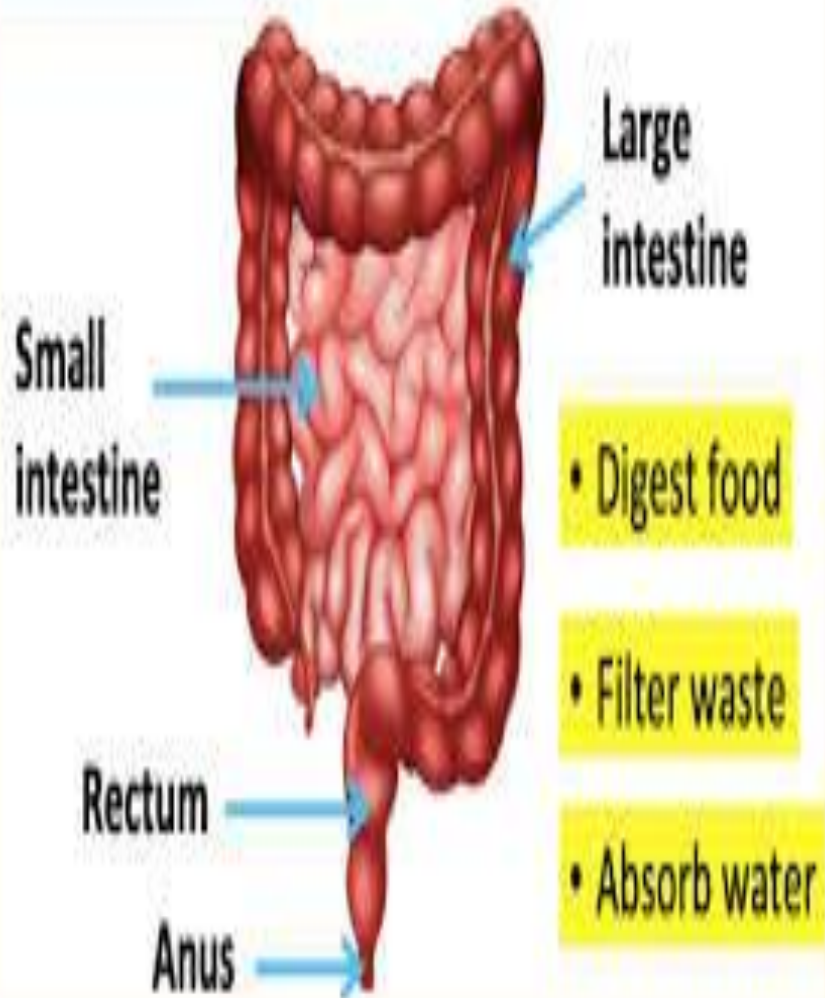
# Functions of the Liver

- Metabolic
- Storage- Glycogen, vitamins (all Fat soluble and few water soluble), iron
- Excretory/Secretory – bile excretion
- Protective (eg. kuffer cells)
- Coagulation – production of clotting factors
- Detoxification of drugs via cytochromes.

# Bile Juice

- Bile is a bitter-tasting, **dark green** to yellowish brown fluid, produced by the **liver** , it is stored in the **gallbladder** and upon eating is discharged into the duodenum. .
- The principal function of the gallbladder is to serve as a storage **reservoir** for bile.
- The main components of bile are water, **bile salts**, bile pigments, and **cholesterol**
- Bile salts act as emulsifying agents in the digestion and absorption of **fats**. Cholesterol and bile pigments from the breakdown of **hemoglobin** are excreted from the body in the **bile**.

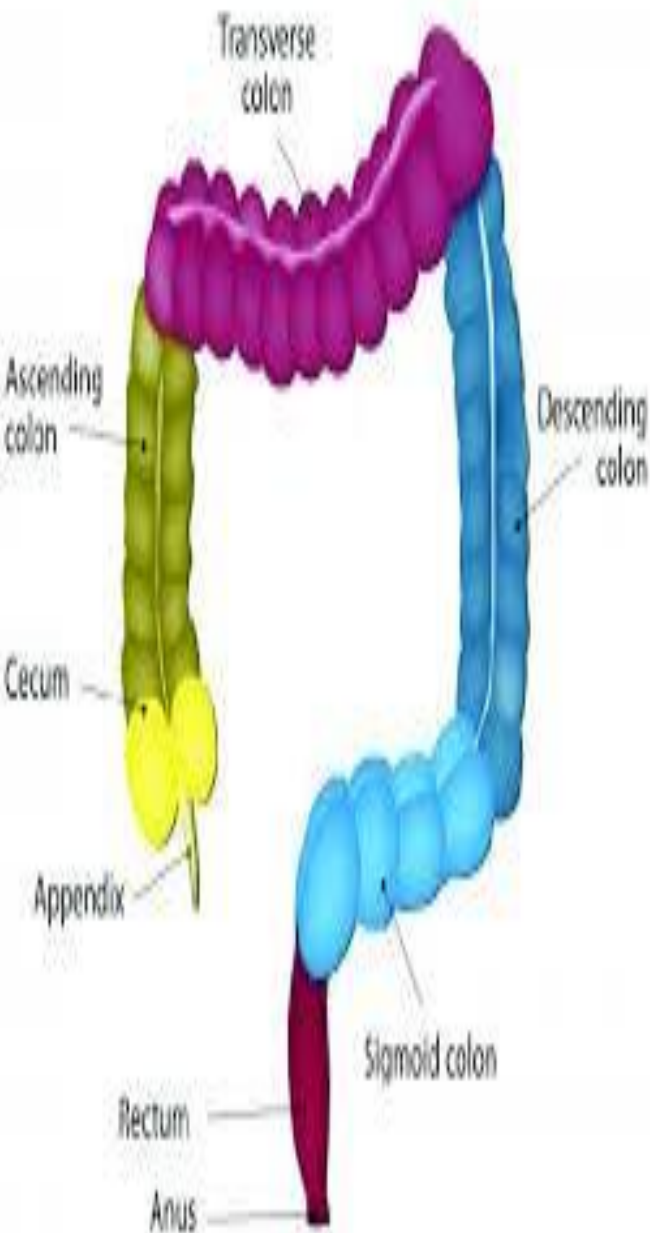
# Intestines Anatomy & functions



# Functions of large intestine

- 3 primary functions:

1. absorbing water and electrolytes,
2. producing and absorbing vitamins,
3. forming and propelling feces toward the rectum for elimination. Convert the liquid contents of the ileum into semisolid feces by absorbing water, salts, and electrolytes. It also stores and lubricates feces with mucus.





Which of these ions is present in saliva and is bactericidal?

Na (a)

K (b)

Cl (c)

Hco<sub>3</sub> (d)

**Thiocyanate** (e)

Which of these cells of gastric glands secretes HCL and intrinsic factor?

Peptic cell (a)

**Parietal cell** (b)

Mucus neck cell (c)

Enteroendocrine cell (d)

Surface mucus cell (e)

# Which of these pancreatic enzymes acts to digest starch?

Trypsin (a)

**Amylase** (b)

Lipase (c)

Chymotrypsin (d)

Phospholipase (e)

The liver acts as an excretory organ for which of these substances?

Glycogen (a)

Fat soluble vitamins (b)

Water soluble vitamins (c)

**Bile** (d)

Iron (e)

Water is absorbed primarily by  
which of these digestive organs?

Stomach (a)

Pancreas (b)

Liver (c)

**Small and large intestine** (d)

Esophagus (e)



Thank

You●