REGULATION OF DIGESTIVE SYSTEM

PHAR-432

LECTURE: 3

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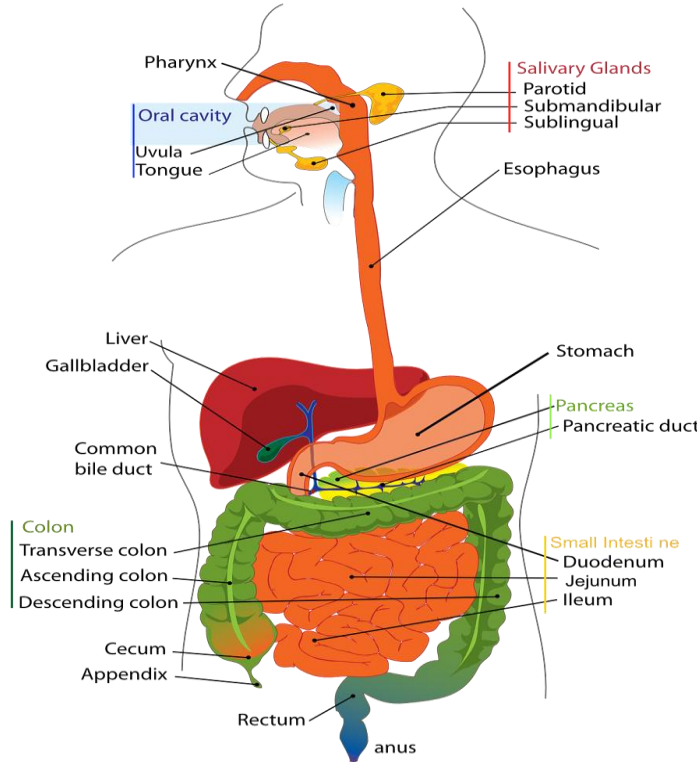
Outlines

- Overview of digestive system
- Notes for healthy GIT
- Digestive process
- Digestion regulation
- Phases of digestion

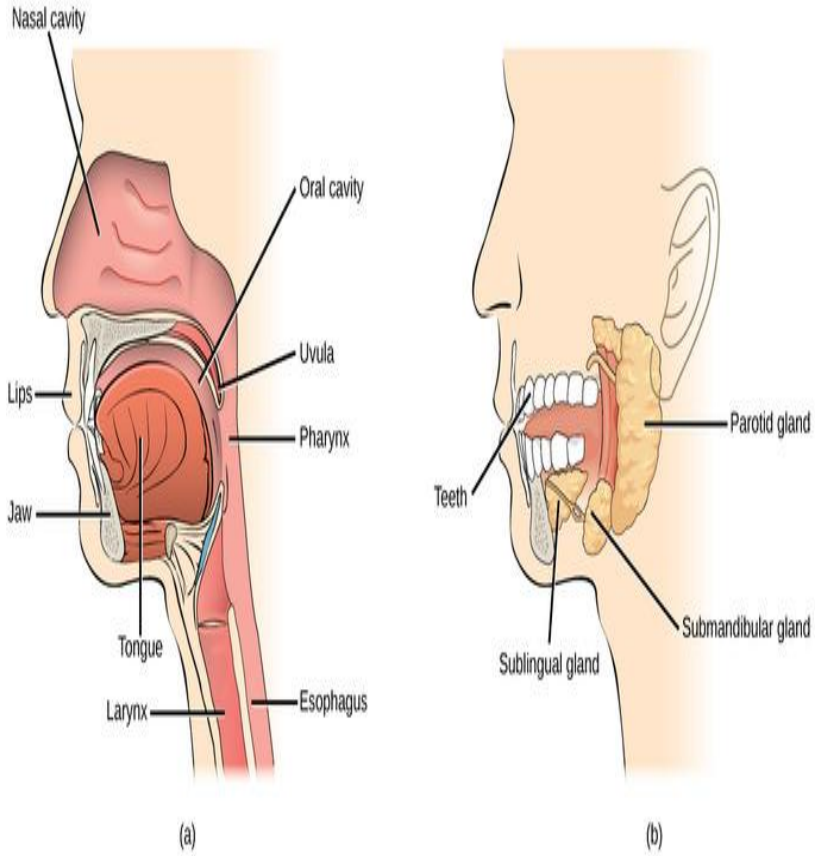
Overview of digestion system

Efficient digestion is essential for overall health because it allows your body to absorb the nutrients it needs to function properly.



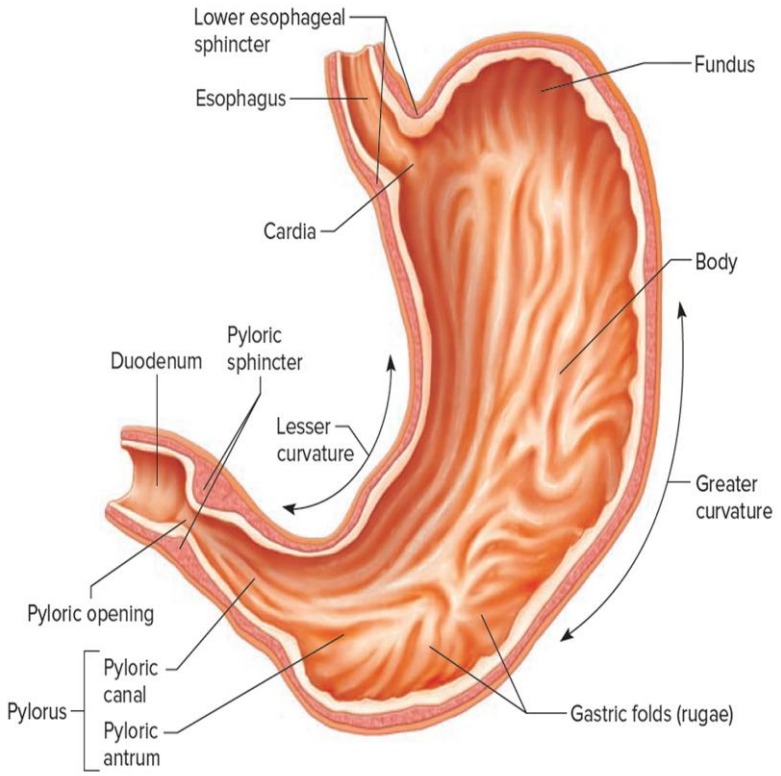
The mouth

- The mouth is the first organ of digestion, where food is broken down mechanically by chewing and chemically by enzymes.
- It secrets : Salivary amylase for breaking dawn starch and Lingual lipase for saturated fatty acids



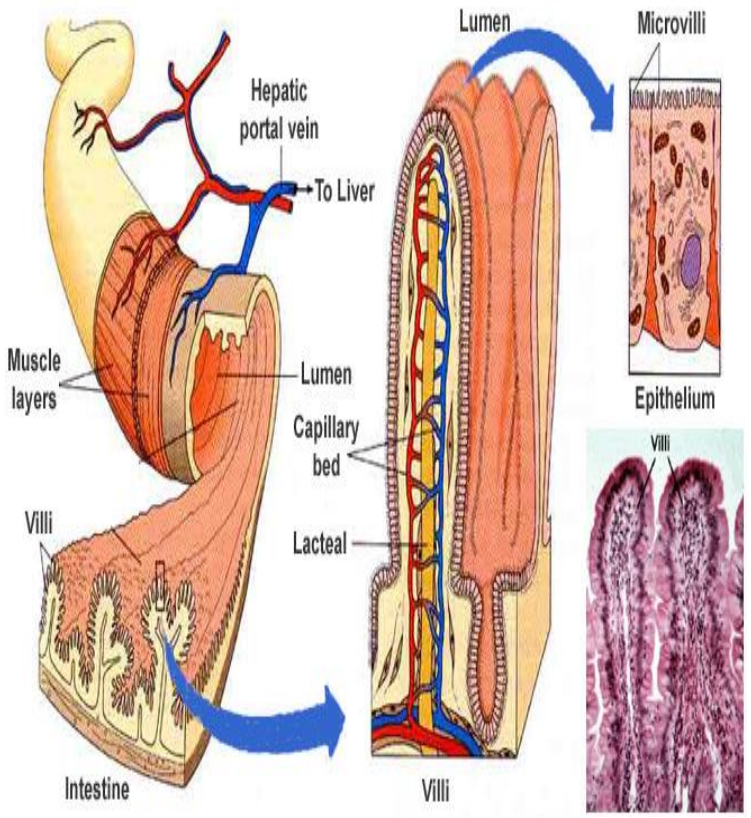
The stomach

- The stomach is the next organ of digestion that release pepsinogen and hydrochloric acid, and they can unite to release the active pepsin.
- The intrinsic factor is released in the stomach and is necessary for the absorption of vitamin B12.
- Low vitamin B12 levels can be due to low hydrochloric acid or a lack of intrinsic factor.
- And low vitamin B12 is a common cause of anemia.



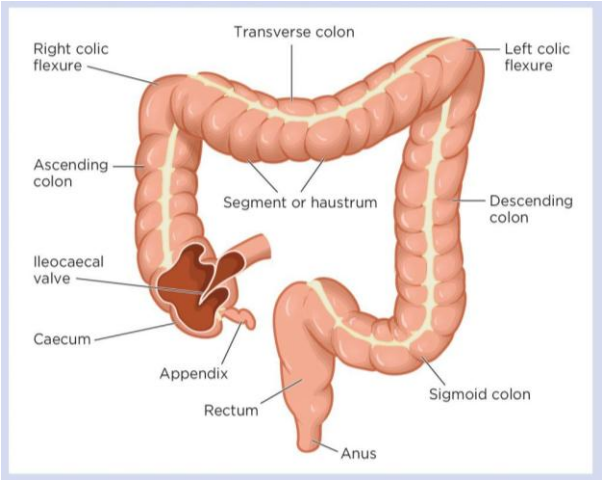
The small intestine

- The small intestine is the next organ of digestion and is where most nutrient absorption occurs.
- The duodenum, receives bile from the liver and gallbladder, and pancreatic enzymes from the pancreas.
- Bile breaks down LCFA, while pancreatic lipase finalizes the breakdown of unsaturated fats.
- Pancreatic amylase finalizes the digestion of starch, while trypsin and chymotrypsin, enzymes released by the pancreas, finalize protein digestion.



The large intestine

- The large intestine is responsible for processing indigestible food material (chyme) after most nutrients are absorbed in the small intestine.
- Functions are: absorbing water and electrolytes, producing and absorbing vitamins, and forming and propelling feces toward the rectum for elimination.
- The appendix is not a mistake and has a nickname "the colon's oil can" because it lubricates the contents that come out of the small intestine.



Notes for healthy gut

- The colon needs **fiber** to function properly and take water out to form stools.
- Hydrotherapy treatments such as **sitz baths** can help bring relief and speed up healing for **hemorrhoids.**
- Drinking **lemon juice** or taking **can pepper** before meals can help **increase hydrochloric acid production** and **improve digestion.**
- **Proteolytic enzymes,** such as **bromelain** and **papain**, can help break down protein and are beneficial for people with **pancreatic problems.**
- Herbs such as **ginger**, **dandelion**, and **milk thistle** can stimulate the release of digestive enzymes and **improve digestion.**

High-fiber foods for better colon health

Hydrotherapy treatment to relieve hemorrhoids

Lemon juice & cayenne pepper for better digestion

Digestive enzymes & herbs to aid digestion

The Digestive Process

- The digestive process can be broken down into five main stages:

1. **Ingestion:** This is the act of putting food into your mouth.
2. **Propulsion:** This is the movement of food through the digestive system.
3. **Mechanical and chemical digestion:** This is the breakdown of food into smaller pieces and molecules.
4. **Absorption:** This is the process of nutrients passing from the digestive system into the bloodstream.
5. **Defecation:** This is the elimination of waste products from the body.

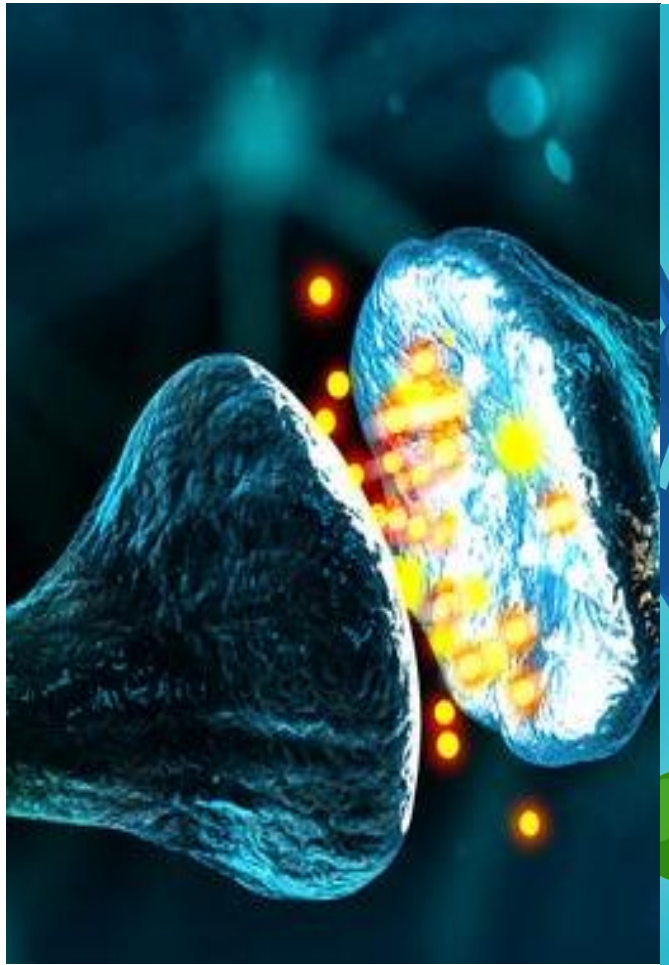
Absorption in different parts od digestive system

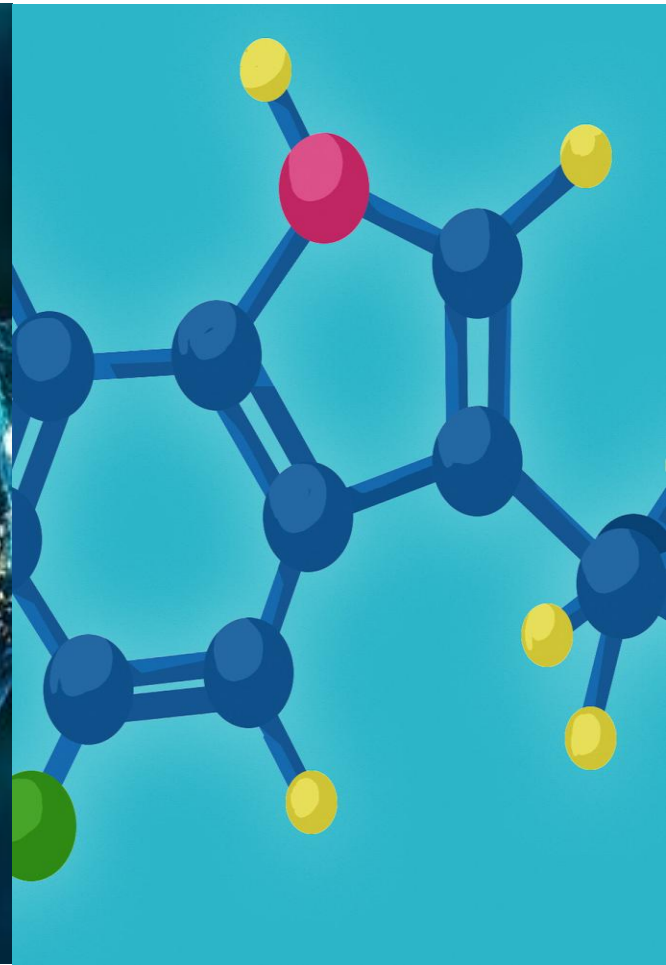
Oral cavity	Stomach	Small Intestine	Large Intestine
Certain drugs coming in contact with the mucosa of the mouth and lower side of the tongue are absorbed into the blood capillaries lining them.	Water, simple sugars, alcohol	Glucose Fructose Fatty acids Glycerol Amino acids	Water , some minerals, drugs

Regulation of digestion

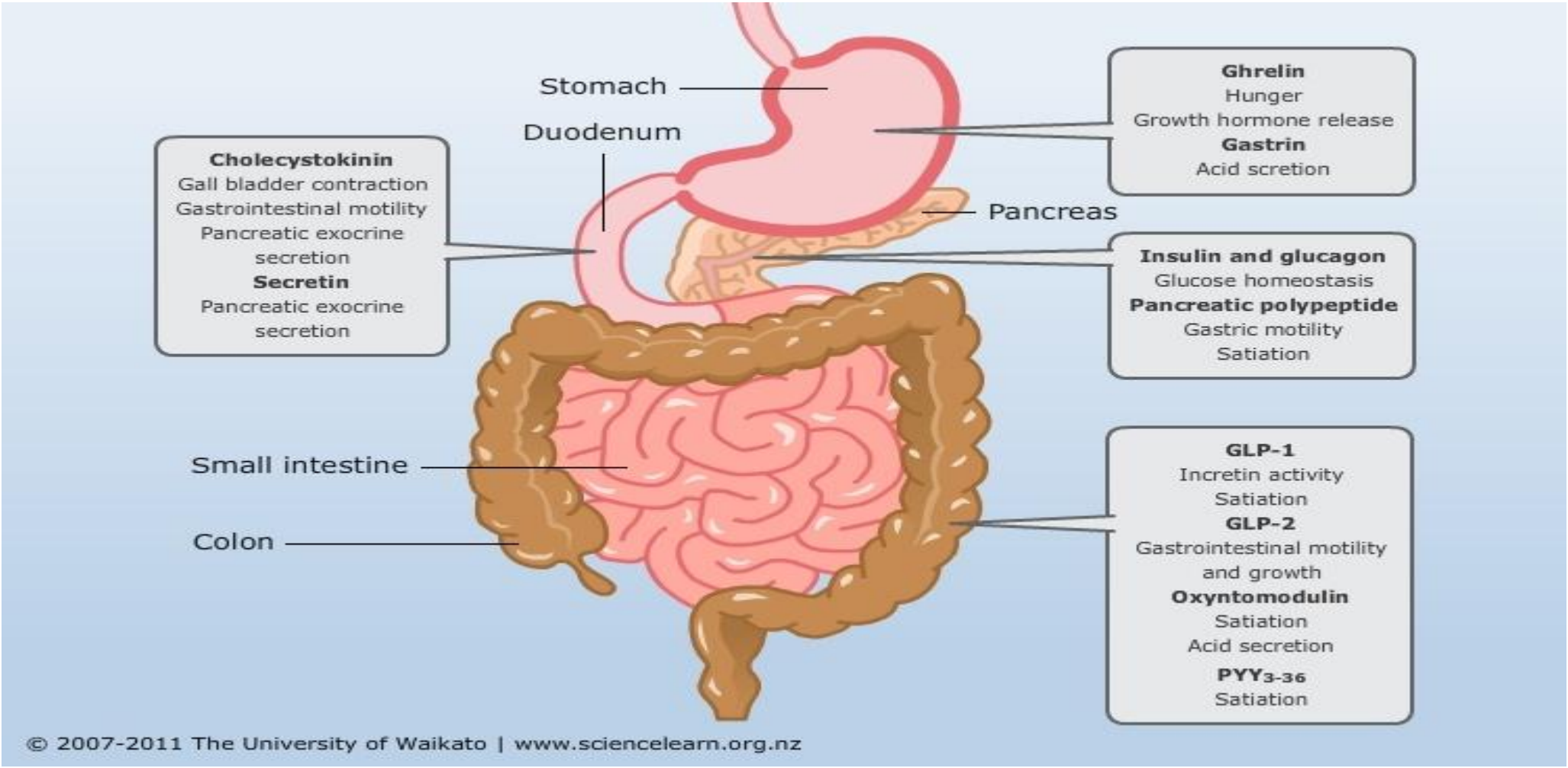
- The activities of the digestive system are regulated by:

1. **Hormones**
2. **Neural reflexes.**





Hormones and their effects on target cells



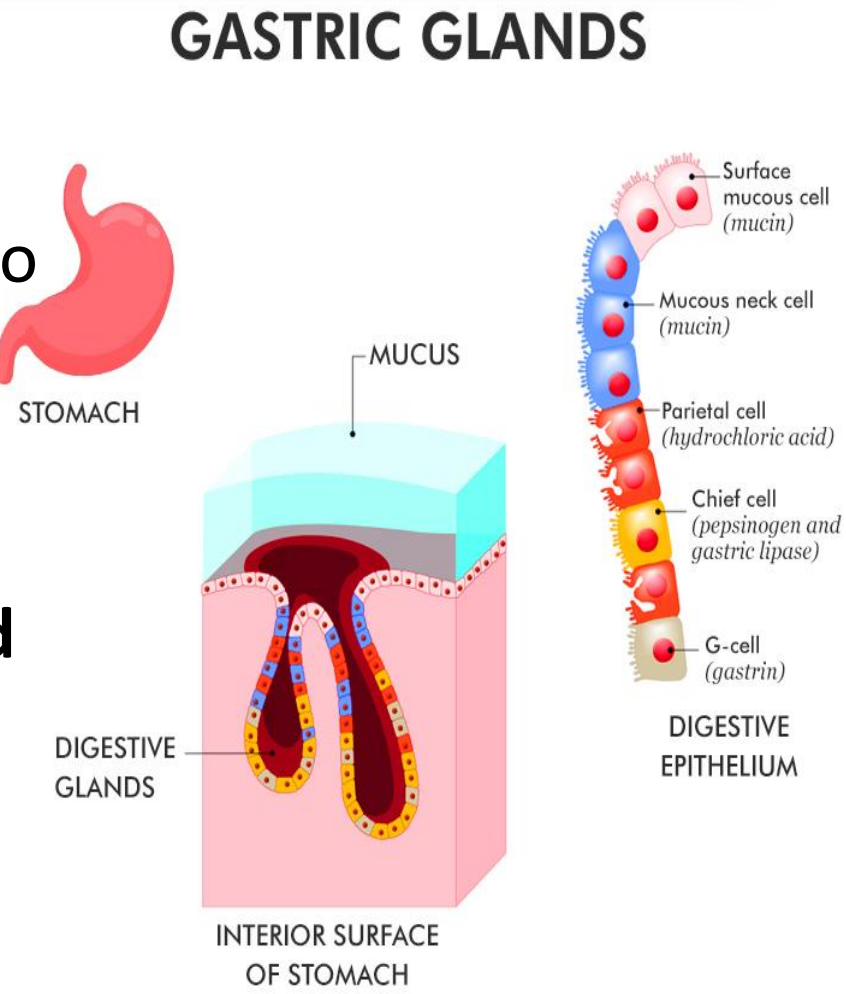
Gastrin

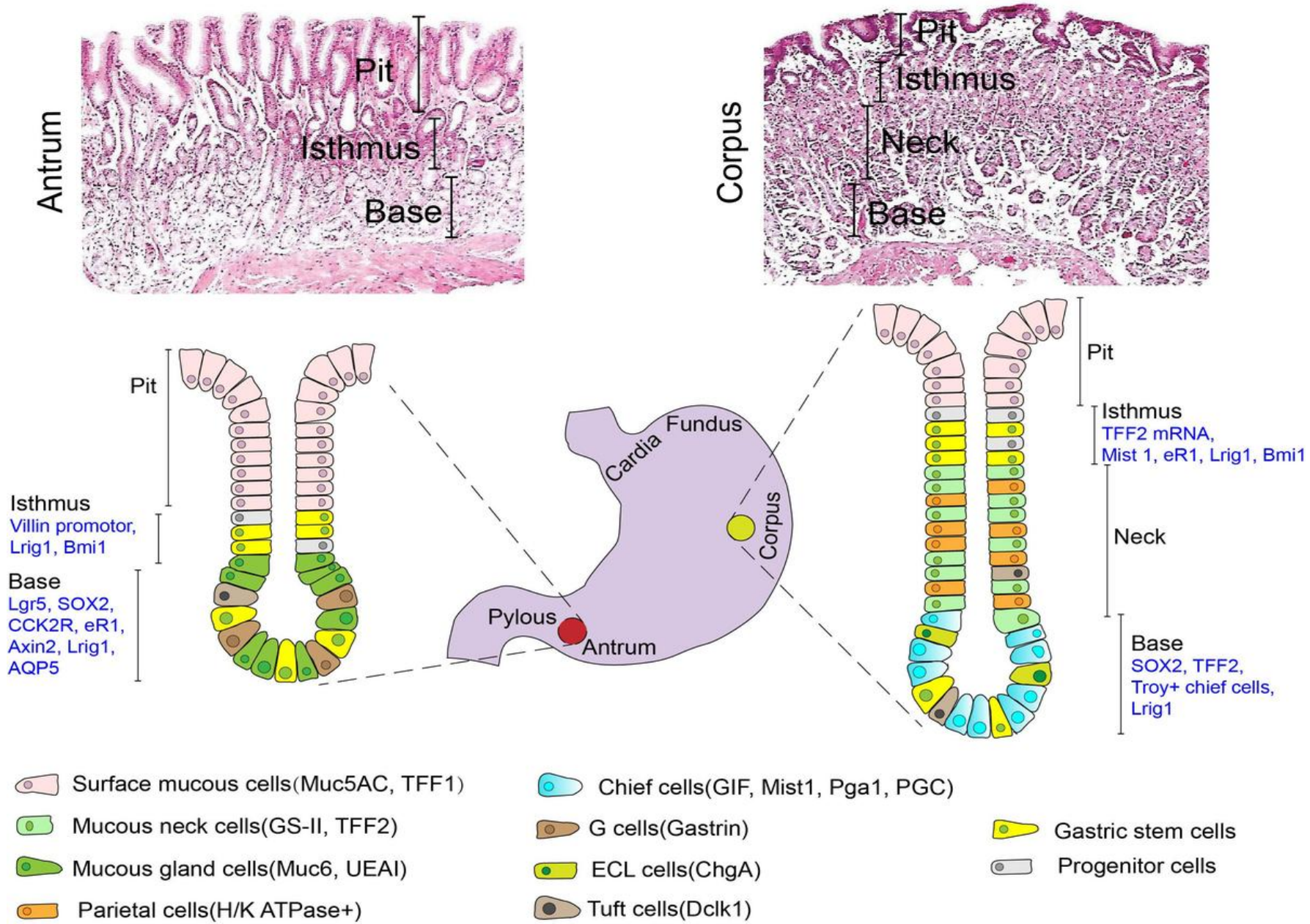
Gastrin is produced by G cells (endocrine cells) of the stomach mucosa.

G-cells release gastrin → bloodstream → travels to stomach body.

Why Blood Release Is Necessary?

G-cells are located in the **antrum**, but acid-secreting parietal cells are mainly in the **body and fundus** of the stomach.




Antrum
Pit
Isthmus
Base
Corpus
Pit
Isthmus
Neck
Base
Pit
Isthmus
Villin promotor,
Lrig1, Bmi1
Base
Lgr5, SOX2,
CCK2R, eR1,
Axin2, Lrig1,
AQP5
Fundus
Cardia
Corpus
Pylous
Antrum
Pit
Isthmus
TFF2 mRNA,
Mist 1, eR1, Lrig1, Bmi1
Neck
Base
SOX2, TFF2,
Troy+ chief cells,
Lrig1
Surface mucous cells(Muc5AC, TFF1)
Mucous neck cells(GS-II, TFF2)
Mucous gland cells(Muc6, UEAI)
Parietal cells(H/K ATPase+)
Chief cells(GIF, Mist1, Pga1, PGC)
G cells(Gastrin)
ECL cells(ChgA)
Tuft cells(Dclk1)
Gastric stem cells
Progenitor cells

Gastrin Acts on Target Cells

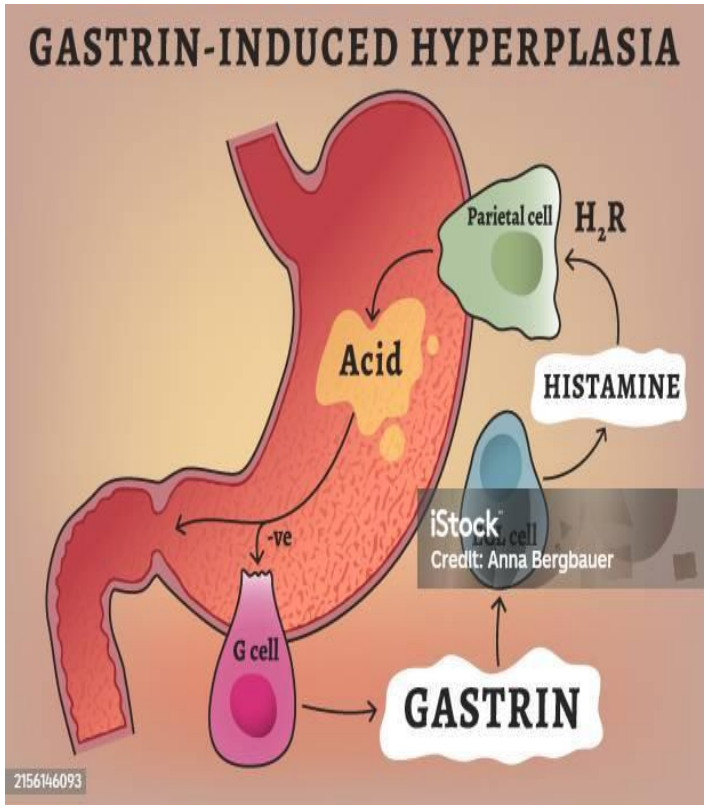
Gastrin stimulates acid secretion by **two pathways**:

- **Direct Pathway**

Gastrin binds receptors on **parietal cells** → HCl secretion.

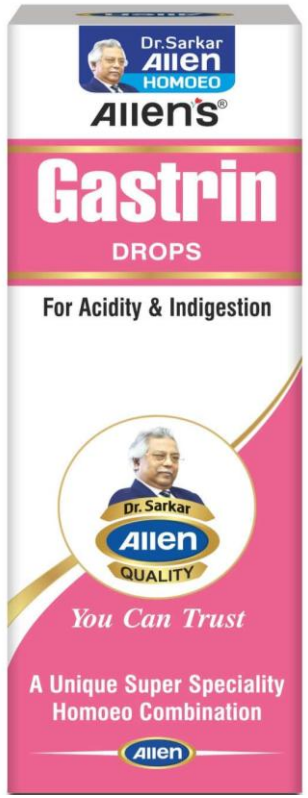
- **Indirect Pathway (Most Important)**

Gastrin stimulates **ECL cells** → release **histamine** → histamine strongly activates parietal cells → massive acid secretion.



Main Functions of Gastrin

- Stimulation gastric juice secretion
- Promotes Gastric Motility: Improves mixing of food with gastric juice
- Relaxation of the pyloric sphincter.



Gastrin regulation

✔️ Stimulators

- Protein-rich meals
- Stomach distension
- Vagus nerve stimulation (via GRP)
- Increased gastric pH (less acidity)

❌ Inhibitors

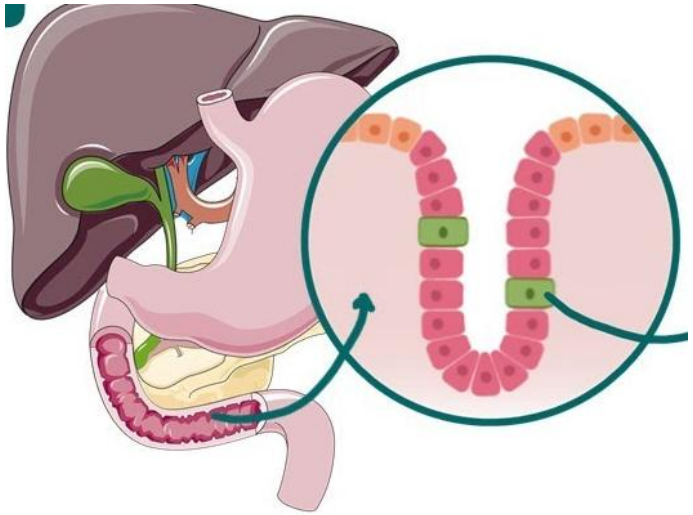
- Low gastric pH (high acidity)
- Somatostatin (main inhibitor)
- Secretin
- Gastric inhibitory peptide (GIP)

Secretin

Secretin is produced by the enteroendocrine cells (S cells) of the duodenal mucosa.

Effects include:

- Stimulation of bicarbonate secretion by the pancreas, which stabilizes the pH of the chyme when released into the duodenum.
- Stimulation of bile production by the liver
- Inhibition of gastric juice secretions and gastric motility, which in turn slows digestion in the stomach and retards gastric emptying.



Glucose insulinotropic peptide (GIP)

- Glucose insulinotropic peptide (GIP) is produced and released by the intestinal K-cells upon nutrient ingestion, in response to the presence of the glucose in the small intestine.
- This hormone stimulates the pancreas to begin releasing insulin, and promotes fat storage.
- GIP is key to type 2 diabetes and obesity treatment, often paired with GLP-1 (e.g., tirzepatide) to improve glycemic control and induce weight loss.

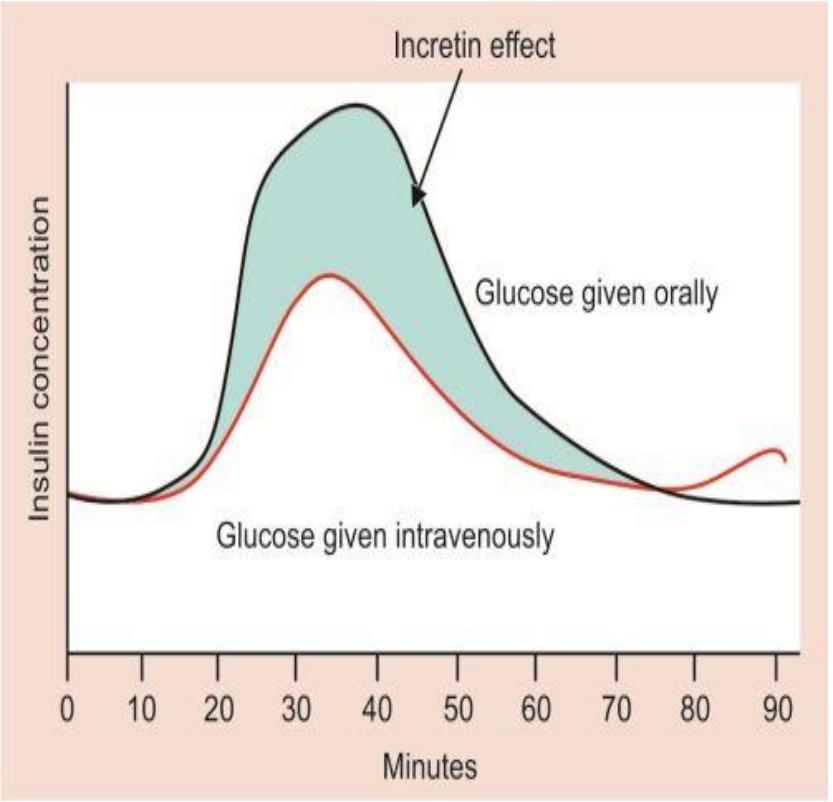
The Incretin Effect of GIP

When glucose is taken orally: Insulin release is **greater** than when glucose is given intravenously.

Why?

Because intestinal hormones (especially GIP) signal:

➡️ *"Food is coming — release insulin early."*



Cholecystokinin (CCK)

Site of release: I cells from small intestine

Stimulant : Proteins and Fats

➢ It's an Appetite suppressant

✔ **Stimulates:**

- Gallbladder contraction
- Pancreatic enzyme secretion
- Somatostatin secretion
- Pancreatic bicarbonate secretion
- Growth of exocrine pancreas

❌ **Inhibits**

Gastric emptying

Gastric acid production

Somatostatin
(Growth Hormone-Inhibiting Hormone, GHIH)

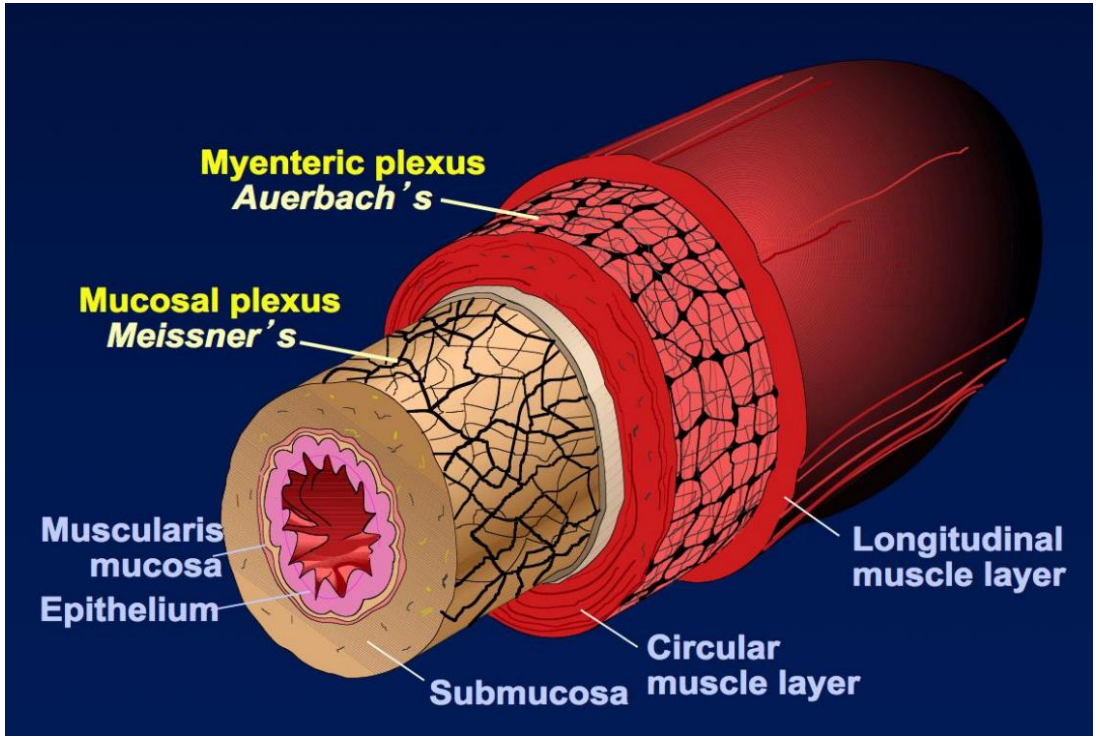
Is a **potent inhibitory peptide** hormone produced in the hypothalamus, pancreas, stomach and intestine.

🧪 **Major Actions of Somatostatin**

- Inhibition of Gastric Acid Secretion
- Inhibition of GI Hormones (gastrin, secretin, CCK,GIP)
- From pancreas, inhibits the release of both insulin and glucagon,
- From hypothalamus, inhibits the release of growth hormone and thyroid-stimulating hormone (TSH) from the anterior pituitary.

GIT neurons

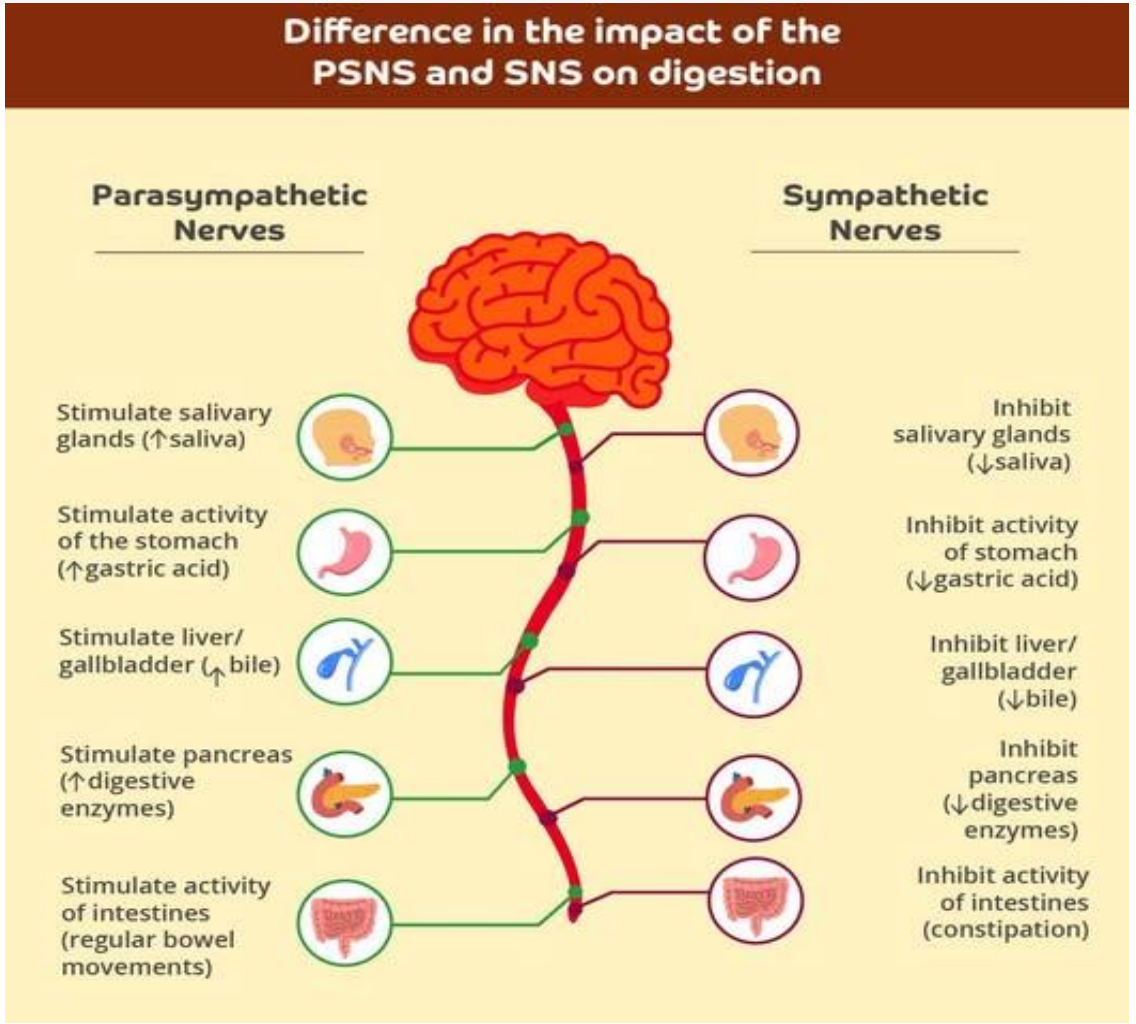
- The Gastrointestinal Tract Has Its Own Nervous System Called the: Enteric Nervous System



Neuronal control of digestive system

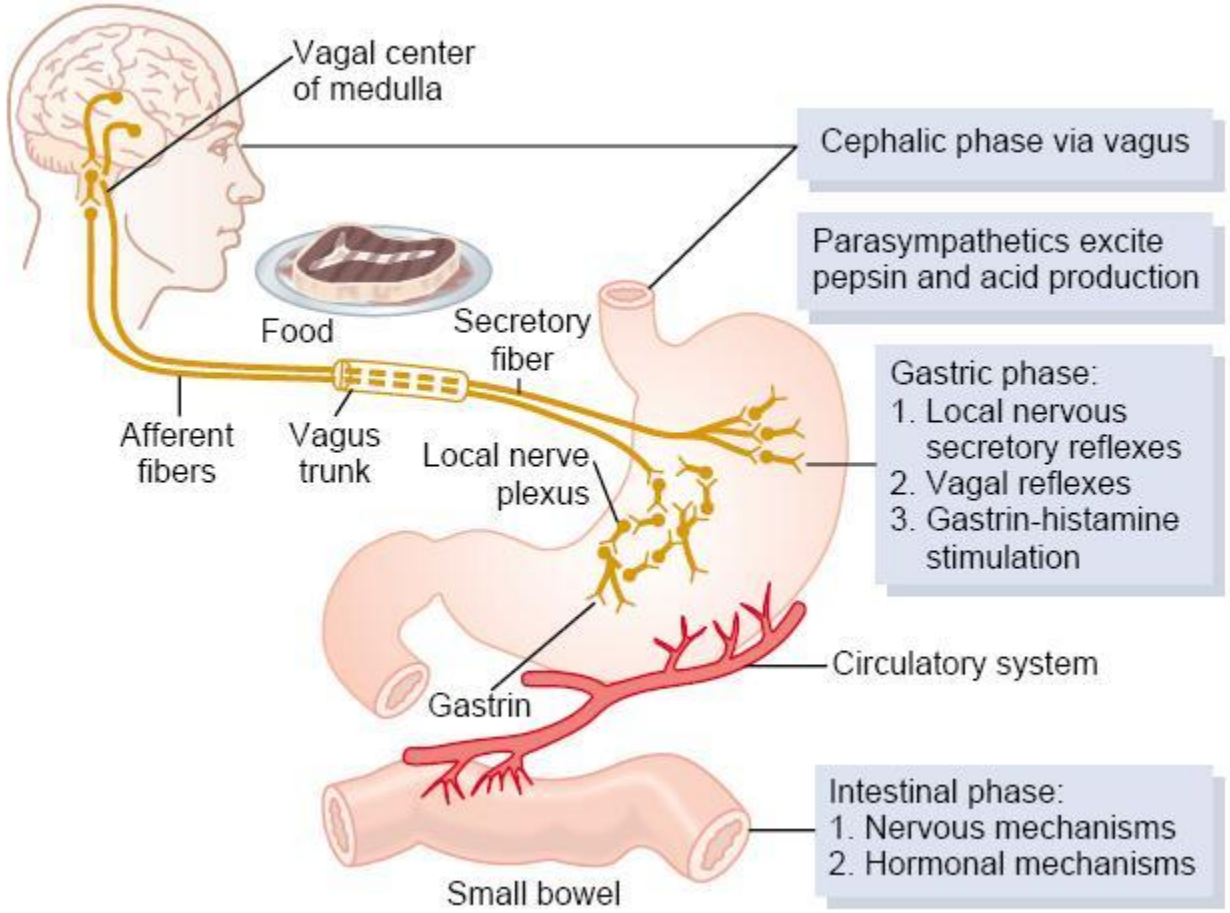
- Autonomic Control of the Gastrointestinal Tract:
- **1-The Parasympathetic Nerves:** activate Activity in the Gastrointestinal Tract

- **2- The Sympathetic Nervous System :** Inhibits Activity in the Gastrointestinal Tract



The phases of digestion

1. Cephalic phase
2. Gastric phase
3. Intestinal phase



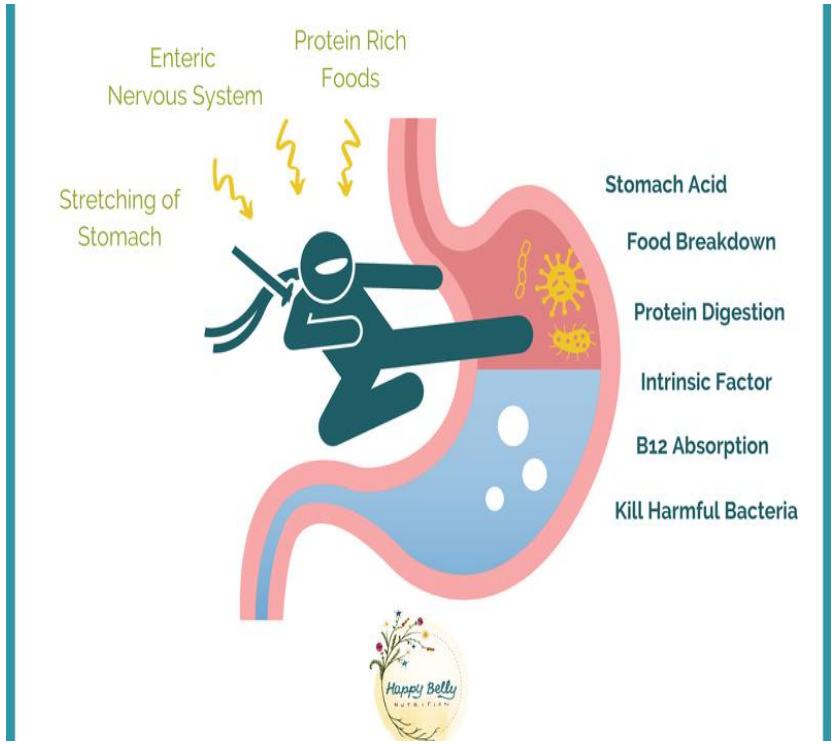
Cephalic phase

- The cephalic phase of digestion, triggered by the sight, smell, or thought of food, initiates the digestive process with the salivary and gastric secretory responses mediated via the autonomic nervous system.

Gastric phase

The gastric phase describes those stimuli that originate from the stomach.

- These stimuli include:
  - Distention (enlargement) of the stomach
  - Low acidity
  - The presence of peptides



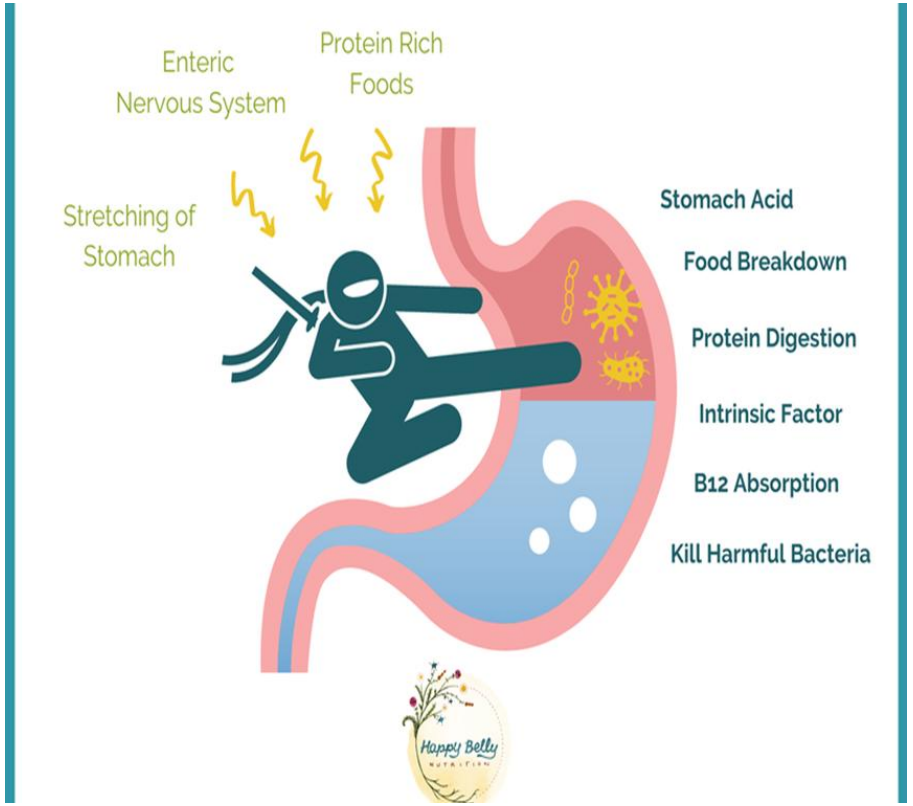
Gastric phase

In response, the following reflexes are initiated:

Neural response: Gastric juice secretion and smooth muscle contraction are promoted.

Hormonal response: Gastrin production is promoted.

General effects: The stomach and small intestine prepare for the digestion of chyme, and gastric emptying is promoted.



Intestinal phase

These include:

✓Distention of the duodenum,

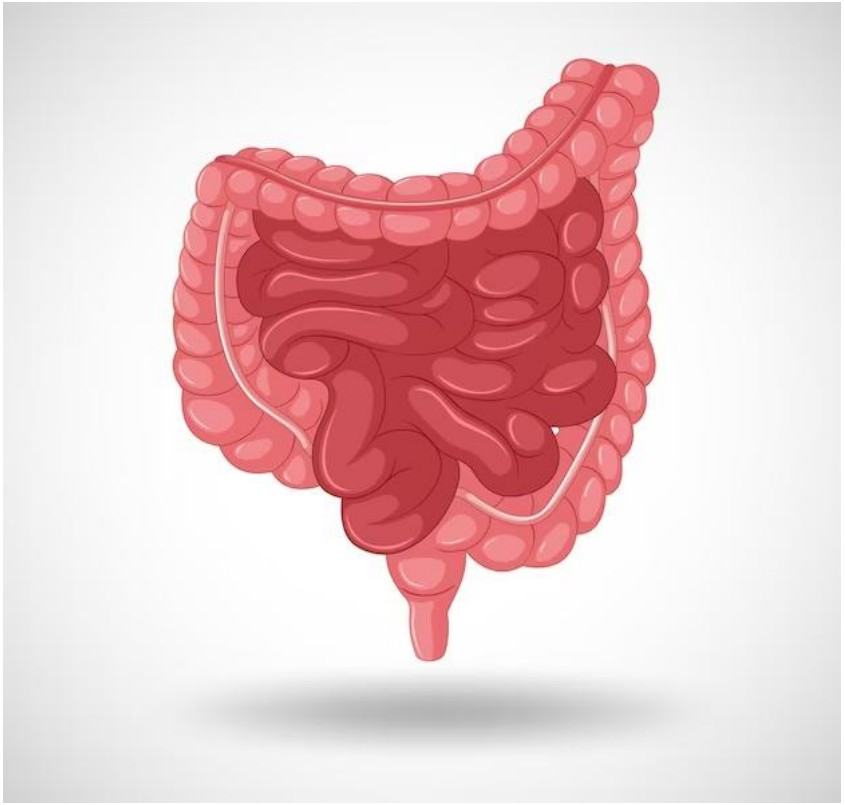
✓High acidity, and

✓The presence of chyme.

In response, the following reflexes are initiated:

Neural response: Gastric secretion and gastric motility are inhibited (enterogastric reflex).

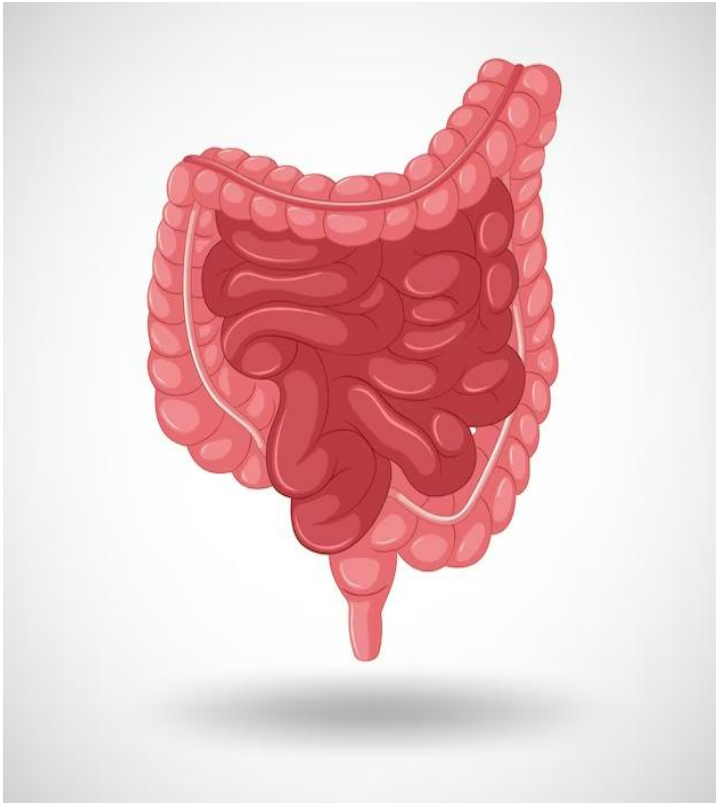
Intestinal secretions, smooth muscle contraction, and bile and pancreatic juice production are promoted.



Intestinal phase

Hormonal response: Production of secretin, CCK, and GIP is promoted.

General effects: Stomach emptying is retarded to allow adequate time for digestion (especially fats) in the small intestine. Intestinal digestion and motility are promoted.



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