Physiology (code)-year 2

Lecture 1 (Digestive system)

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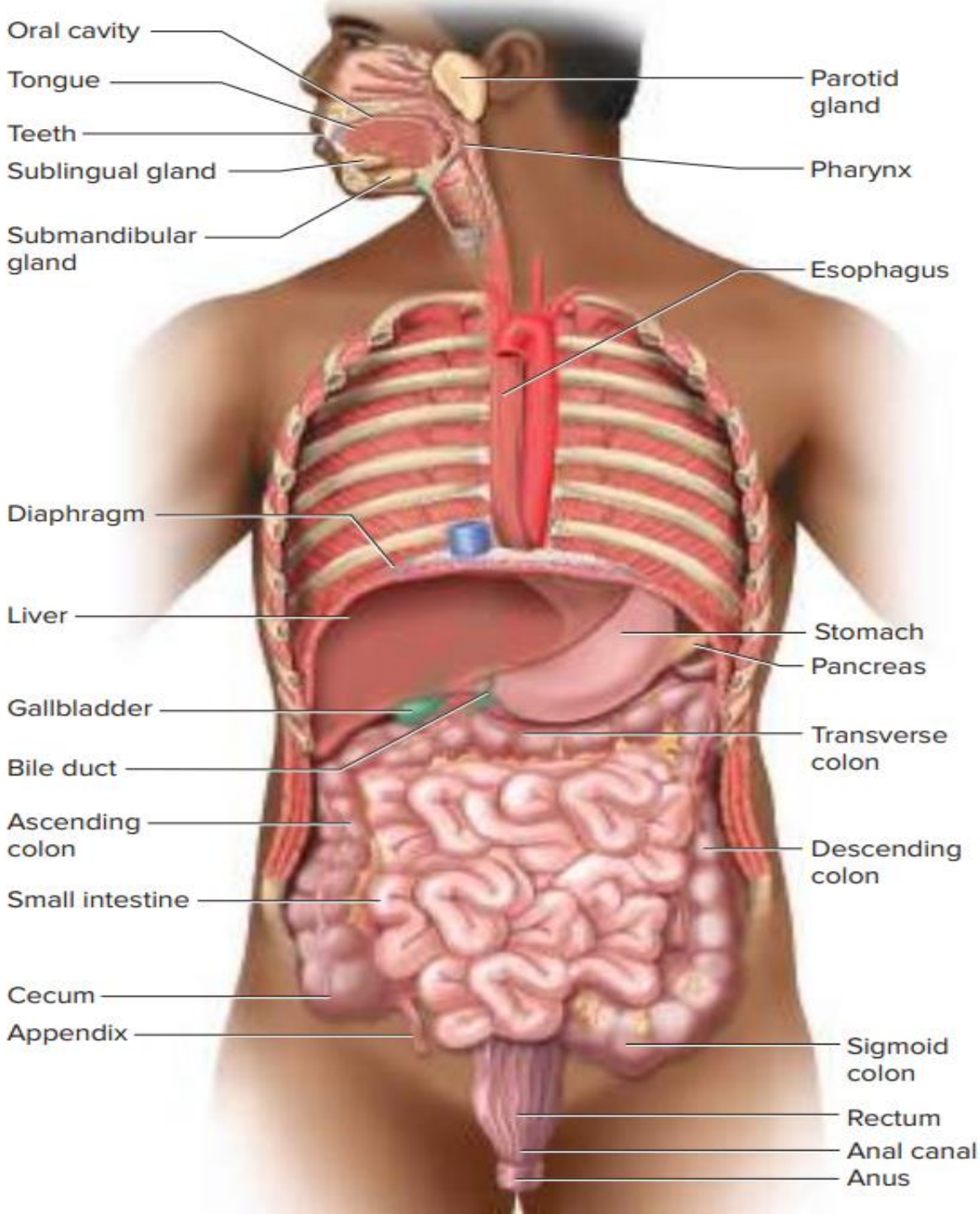
Objectives:

1.Describe the functions of the digestive system, and list it is structures and regions .

2.Describe the functions of the stomach and the gastric secretion and its Control.


Oral cavity
Tongue
Teeth
Sublingual gland
Submandibular gland
Parotid gland
Pharynx
Esophagus
Diaphragm
Liver
Stomach
Pancreas
Gallbladder
Transverse colon
Bile duct
Ascending colon
Descending colon
Small intestine
Cecum
Appendix
Sigmoid colon
Rectum
Anal canal
Anus

• Digestive Function

The digestive system is the organ system that processes food, extracts nutrients from it, and eliminates the residue. It does this in five stages:

1. Ingestion, the selective intake of food;

2. Digestion, the mechanical and chemical breakdown of food into a form usable by the body;

3. Absorption, the uptake of nutrient molecules into the epithelial cells of the digestive tract and then into the blood or lymph;

4. Compaction, absorbing water and consolidating the indigestible residue into feces; and finally,

5. Defecation, the elimination of feces

- **Digestive system includes**: the mouth, pharynx, esophagus, stomach, small intestine, and large intestine
- The teeth, tongue, salivary glands, liver, gallbladder, and pancreas are considered accessory organs of the digestive system.
- The digestive tract is a muscular tube extending from mouth to anus.

Anatomical feature

Most of the digestive tract with a wall composed of the following tissue layers in order from the inner to the outer surface:

1. Mucosa (The inner lining of the digestive tract)

Epithelium

Lamina propria (a loose connective tissue layer)

Muscularis mucosae (a thin layer of smooth muscle)

2. Submucosa (thicker layer of loose connective tissue containing blood vessels and lymphatics, a nerve plexus, and in some places, glands that secrete lubricating mucus into the lumen.

3. Muscularis externa

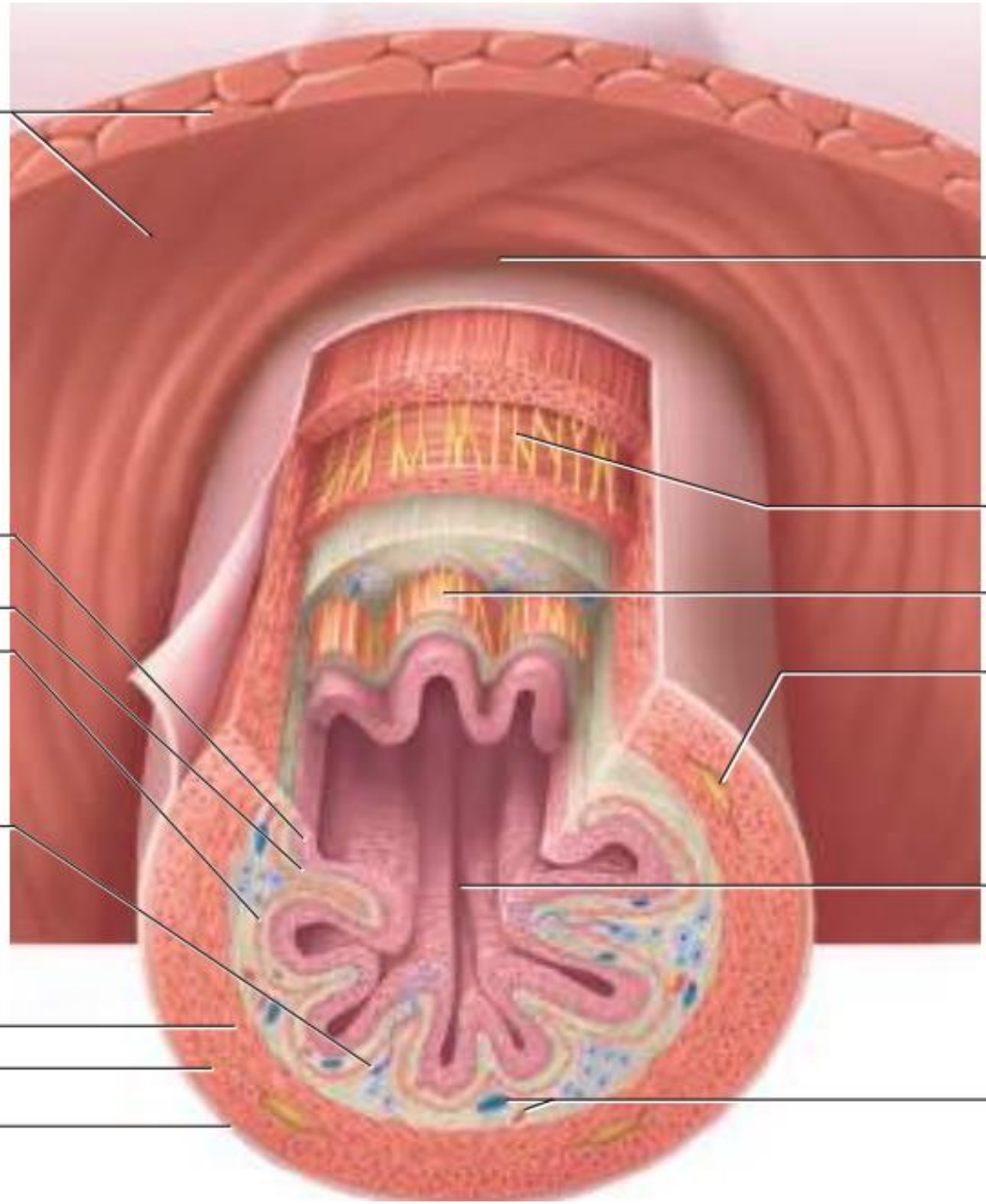
Inner circular layer

Outer longitudinal layer

4. Serosa

Areolar tissue

Mesothelium

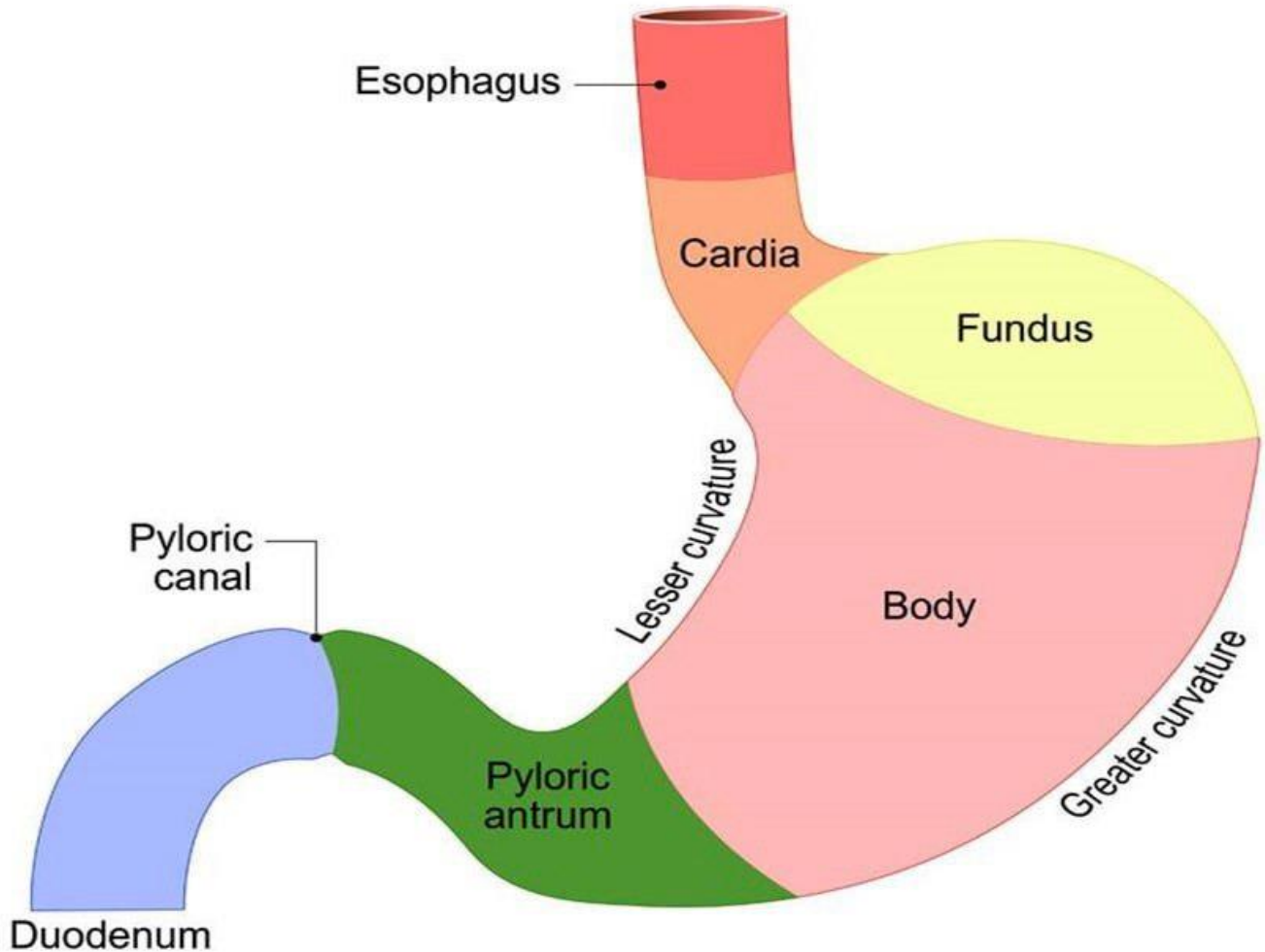

Diaphragm
Esophageal hiatus
Enteric nervous system:
Myenteric plexus
Mucosa:
Stratified squamous epithelium
Lamina propria
Muscularis mucosae
Submucosal plexus
Parasympathetic ganglion of myenteric plexus
Submucosa:
Esophageal gland
Lumen
Muscularis externa:
Inner circular layer
Outer longitudinal layer
Blood vessels
Serosa

THE STOMACH

Stomach is the most dilated part of the gastrointestinal tract, its is divided into five segments: (1) cardia, (2) fundus, (3) corpus or body, (4) antrum (5) pylorus . Each of these segments has histologic differences and is involved in unique roles in the process of digestion .The gastric wall is around 3-4 mm thick and is comprised of four major layers, (1) mucosa, (2) submucosa, (3) muscularis, (4) serosa .So, both mechanical and chemical digestion take place in the stomach.

The digestive actions of the stomach reduce food particles to a solution known as chyme which contains molecule after breaking down amino acids , and produces bile which is needed for emulsification and absorption of lipids in small intestine .

Sections of human the stomach



Main functions of the stomach are:

1. **Storage of food until digested**: When food enters the stomach a vagal reflex greatly reduces the tone in the muscular wall of the body of the stomach, so that the wall can bulge progressively outward accommodating greater and greater quantities of food up to a limit of about (1 liter), this process is called **receptive relaxation**.

2. **Mixing of food** with gastric secretion until it forms a semi fluid mixture called **chyme**. When the stomach is filled, weak peristaltic constrictor waves called **mixing waves**, move toward the antrum along the stomach wall approximately once every 20 seconds. As the constrictor waves progress from the body of the stomach into the antrum, they become more intense, providing powerful peristaltic constrictor rings that force the antral contents under high pressure toward the pylorus.

3. **Slow emptying** of chyme to the duodenum at a rate suitable for proper digestion and absorption by the small intestine.

- ❖ Normal diet takes 3 hours to be emptied to the duodenum.
- ❖ Fasting for 12 hours → increases antral peristalsis → hunger contraction accompanied with pain.

Gastric secretions:

Are aid in the breakdown of food into small particles and continue the process of digestion had begun by the salivary enzymes. The stomach mucosa contains two types of gastric glands:

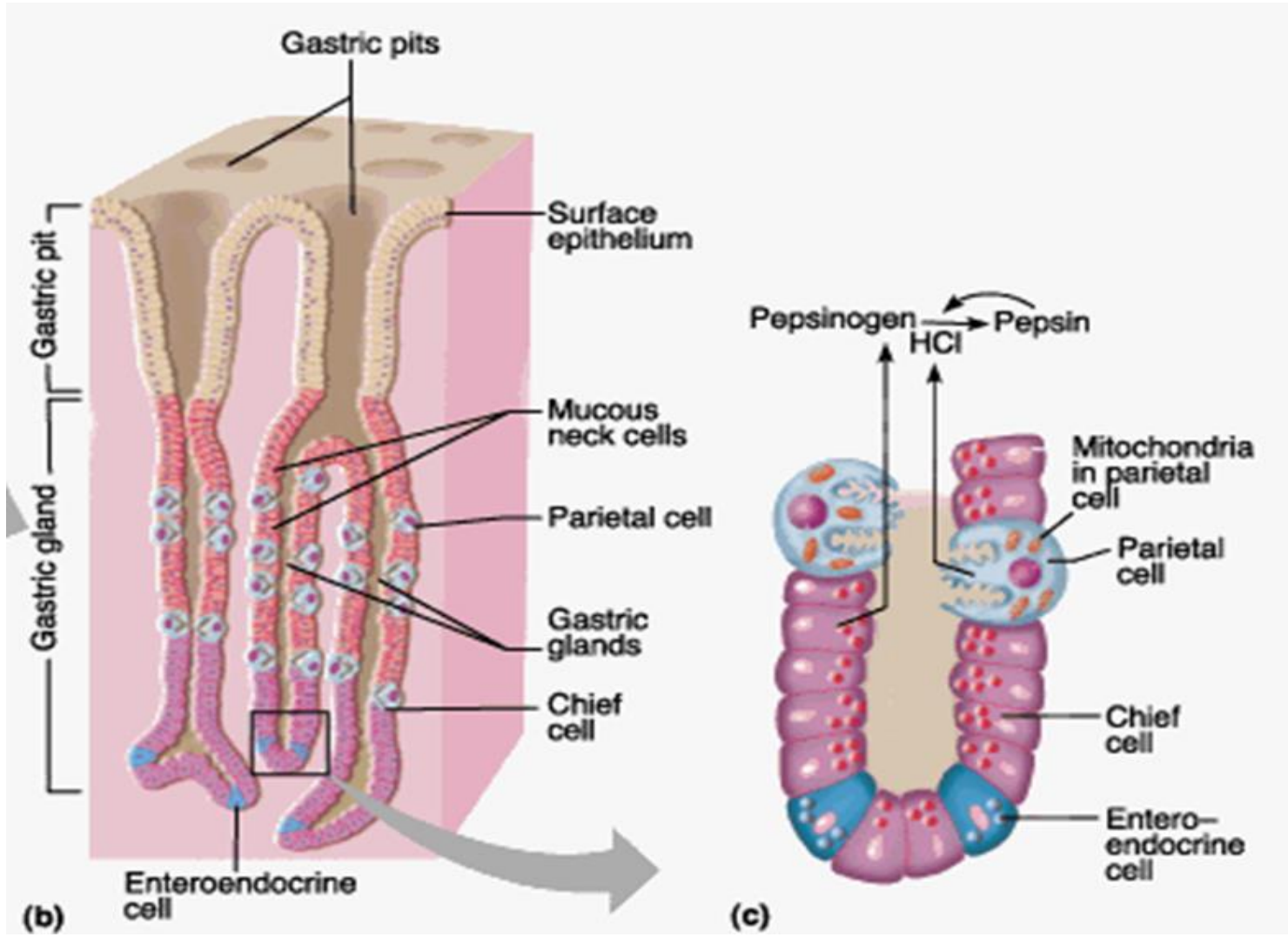
1. Oxyntic glands which are located in the fundus and the body of the stomach, they contain three types of cells:

a. ***Mucus secreting cells*** **that line the surface of the stomach.**

b. ***Oxyntic (parietal) cells*** **which secrete intrinsic factor and HCL.**

c. ***Peptic (chief) cells*** **which secrete pepsinogen.**

2. Pyloric glands which are located in the antral and pyloric regions of the stomach, contain G cells (responsible for the release of the gastrin hormone) and some mucous cells.


Gastric pits
Gastric pit
Gastric gland
Surface epithelium
Mucous neck cells
Parietal cell
Gastric glands
Chief cell
Enteroendocrine cell
(b)
Pepsinogen
HCl
Pepsin
Mitochondria in parietal cell
Parietal cell
Chief cell
Entero–endocrine cell
(c)

Mucous secretion of stomach:

The surface of the stomach mucosa between glands has a continuous layer of mucus cells that secrete large quantities of a viscid and alkaline mucus that coats the mucosa with a mucus gel layer often more than 1mm thick. Thus providing a major shell of protection for the stomach wall from auto digestion by acid as well as contributing to lubrication of food transport.

The irritation of the mucosa directly stimulate the mucus cells to secrete this thick, viscid mucus.

- Patient with peptic ulcer will have a defect in mucous secretion, when damage to the mucosa as it occurs due to highly concentrated HCL, 10% ethanol, drugs (e.g. aspirin) and smoking , allows pepsin and HCL to penetrate the mucosal barrier and destroy mucosal cells, this liberates histamine, which increases acid secretion and produces increased capillary permeability and vasodilatation and lead to edema. Direct exposure of mucosal capillaries to the digestive process and lead to bleeding.
- The mucous layer covering is only found in stomach
- Patient with lower esophageal sphincter incompetence → regurgitation of gastric juice → reflex esophagitis (heart burn).

HCL secretion by stomach:

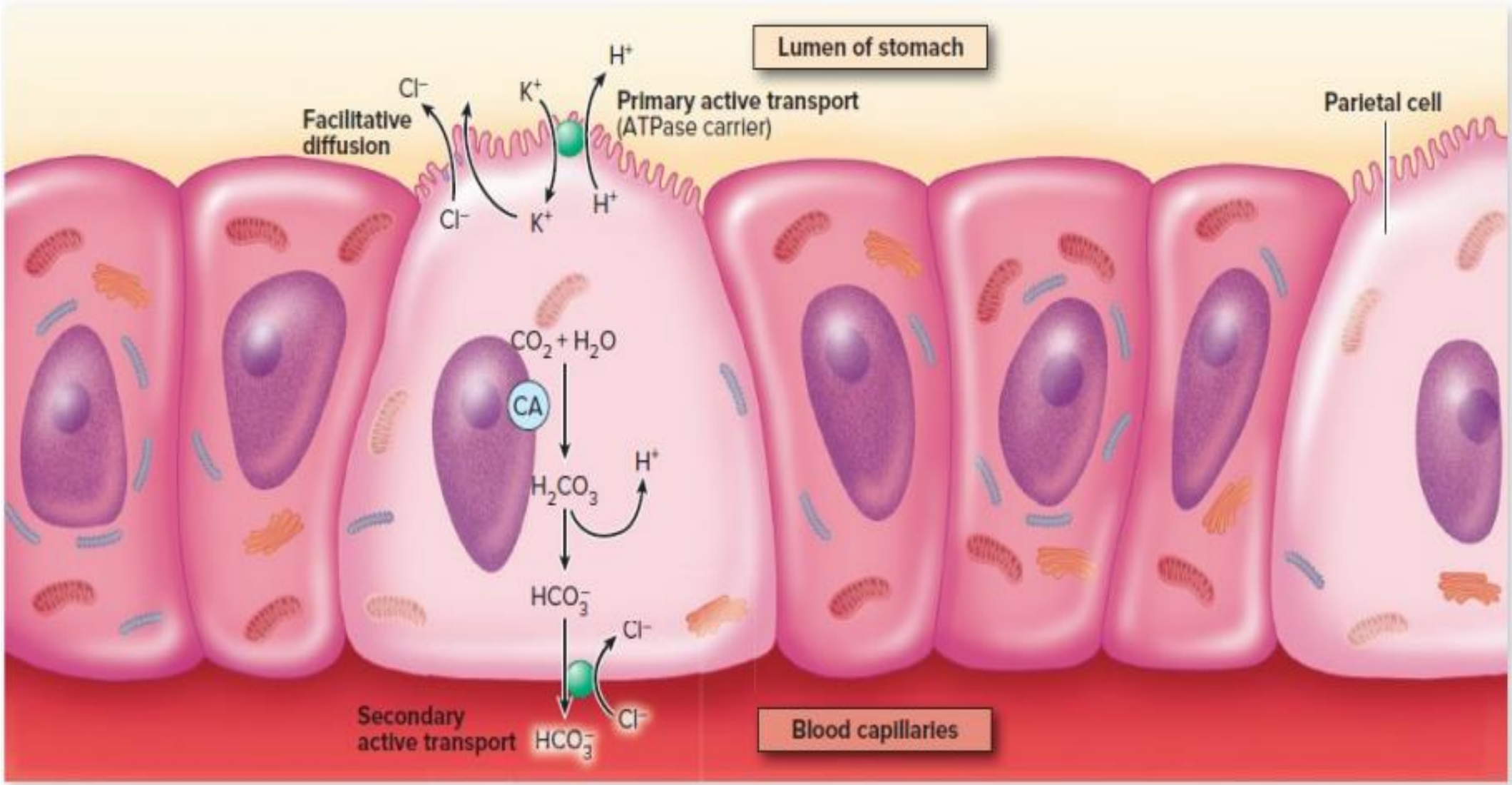
Functions of HCL:

1. Important for activation of pepsinogen to pepsin.
2. Aid in protein digestion (due to formation of pepsin).
3. Kills bacteria, viruses, and many toxins.
4. Converts the dietary ferric Fe^{+3} to ferrous Fe^{+2} , which is better absorbed.

Without HCL the person→ decrease iron absorption suffer → iron deficiency anemia.

Mechanism of HCL secretion:

- **Secretion of gastric acid by parietal cells :**The apical membrane (facing the lumen) secretes H + in exchange for K + using a primary active transport carrier that is powered by the hydrolysis of ATP.
- The basolateral membrane (facing the blood) secretes bicarbonate (HCO_3^-) in exchange for Cl^-. The Cl^- moves into the cell against its electrochemical gradient, powered by the downhill movement of HCO_3^- out of the cell.
- This HCO_3^- is produced by the dissociation of carbonic acid (H_2CO_3), which is formed from CO_2 and H_2O by the action of the enzyme carbonic anhydrase (abbreviated CA).
- The Cl^- then leaves the apical portion of the membrane by diffusion through a membrane channel. The parietal cells thus secrete HCl into the 1. 2. 3. stomach lumen as they secrete HCO_3^- into the blood.


Lumen of stomach
Cl⁻
K⁺
H⁺
Facilitative diffusion
Primary active transport (ATPase carrier)
Parietal cell
Cl⁻
K⁺
H⁺
$CO_2 + H_2O$
CA
H_2CO_3
H⁺
HCO_3^-
Cl⁻
Secondary active transport
HCO_3^-
Cl⁻
Blood capillaries

Transmitters involved in HCL secretion:

1.Histamine

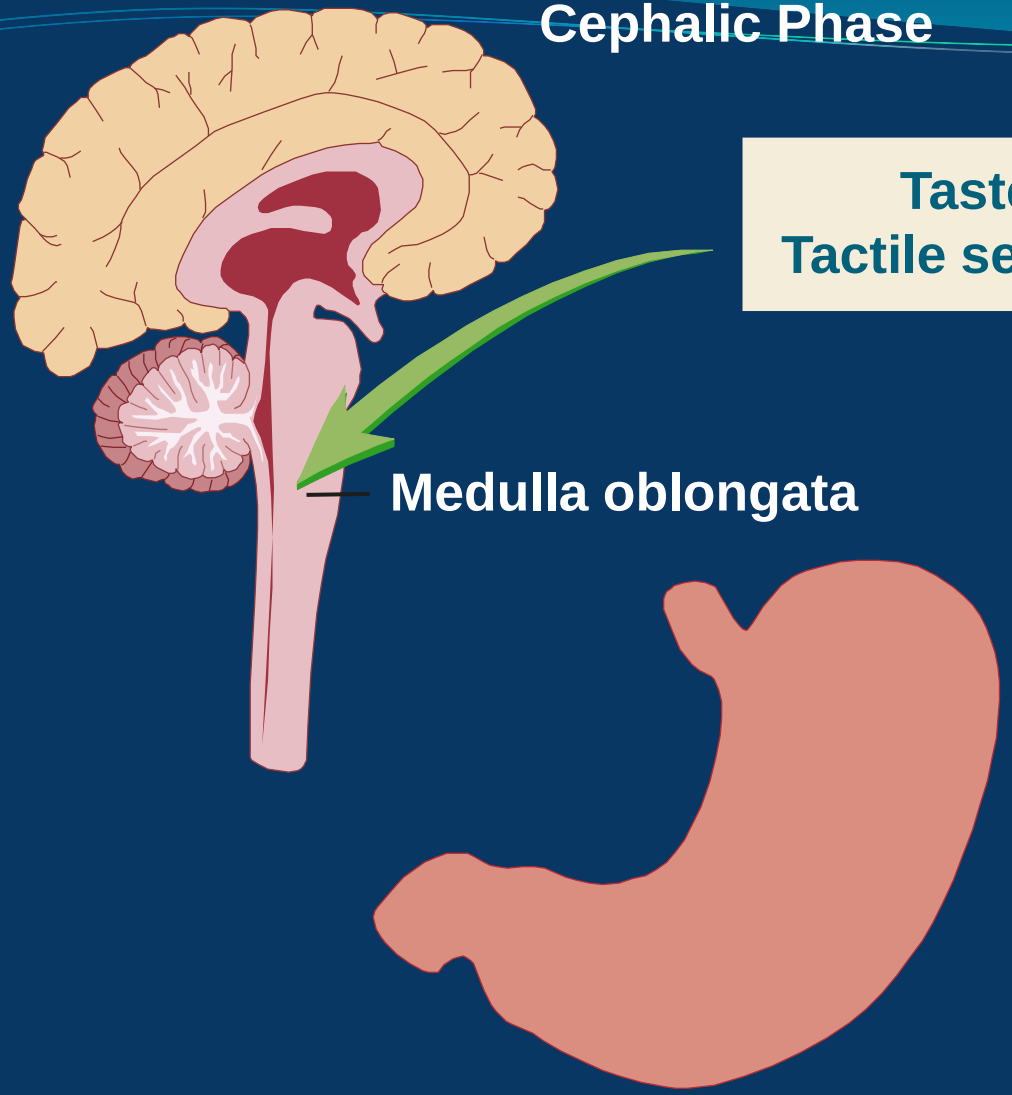
2.Acetyl choline

3. Gastrin hormone

Control of gastric secretion:

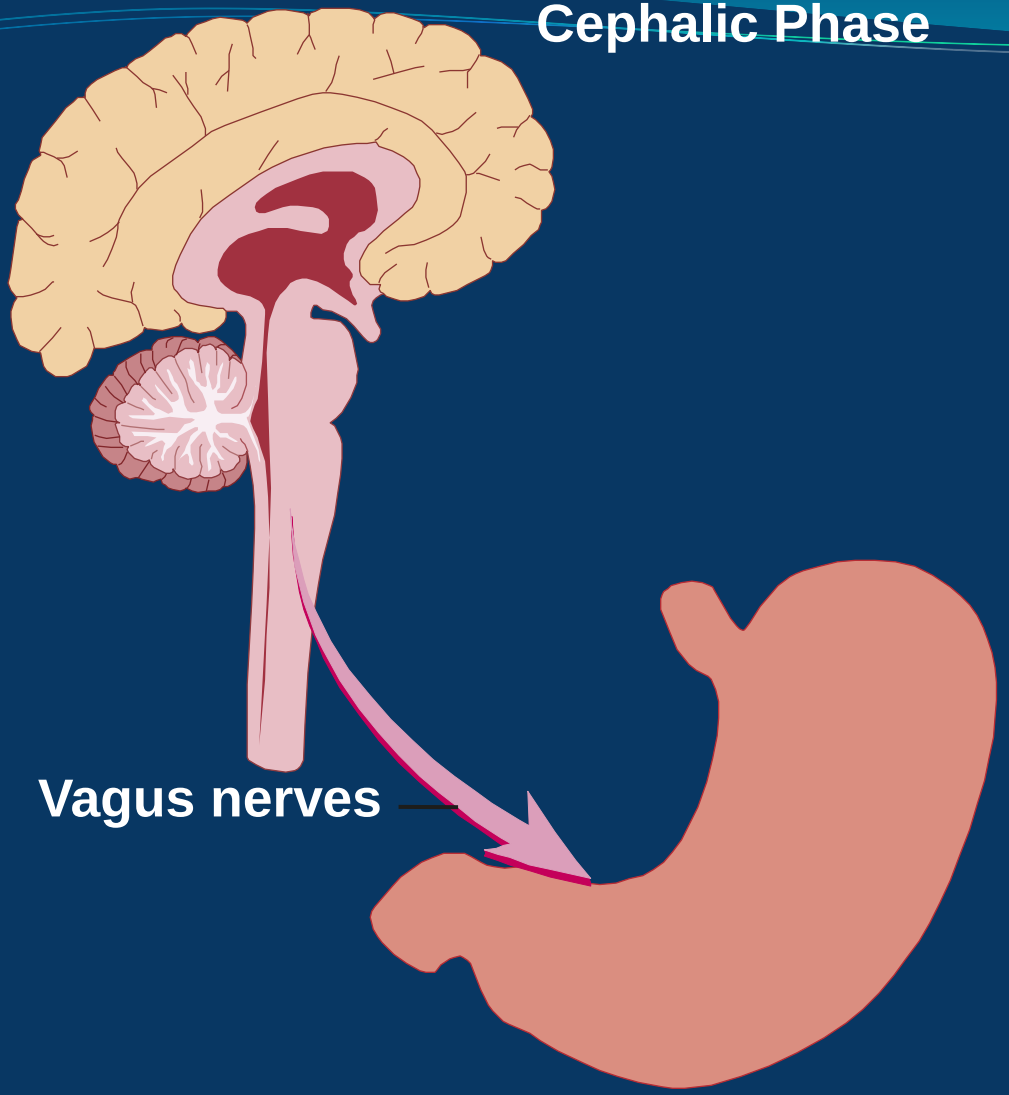
1. ***Cephalic phase*** **:**this is responsible for about 1/3 of gastric juice secreted /day.
2. ***Gastric phase*****:** this is responsible for 2/3 of gastric juice /day.
3. ***Intestinal phase*** **:**can be present but not always.

Cephalic Phase



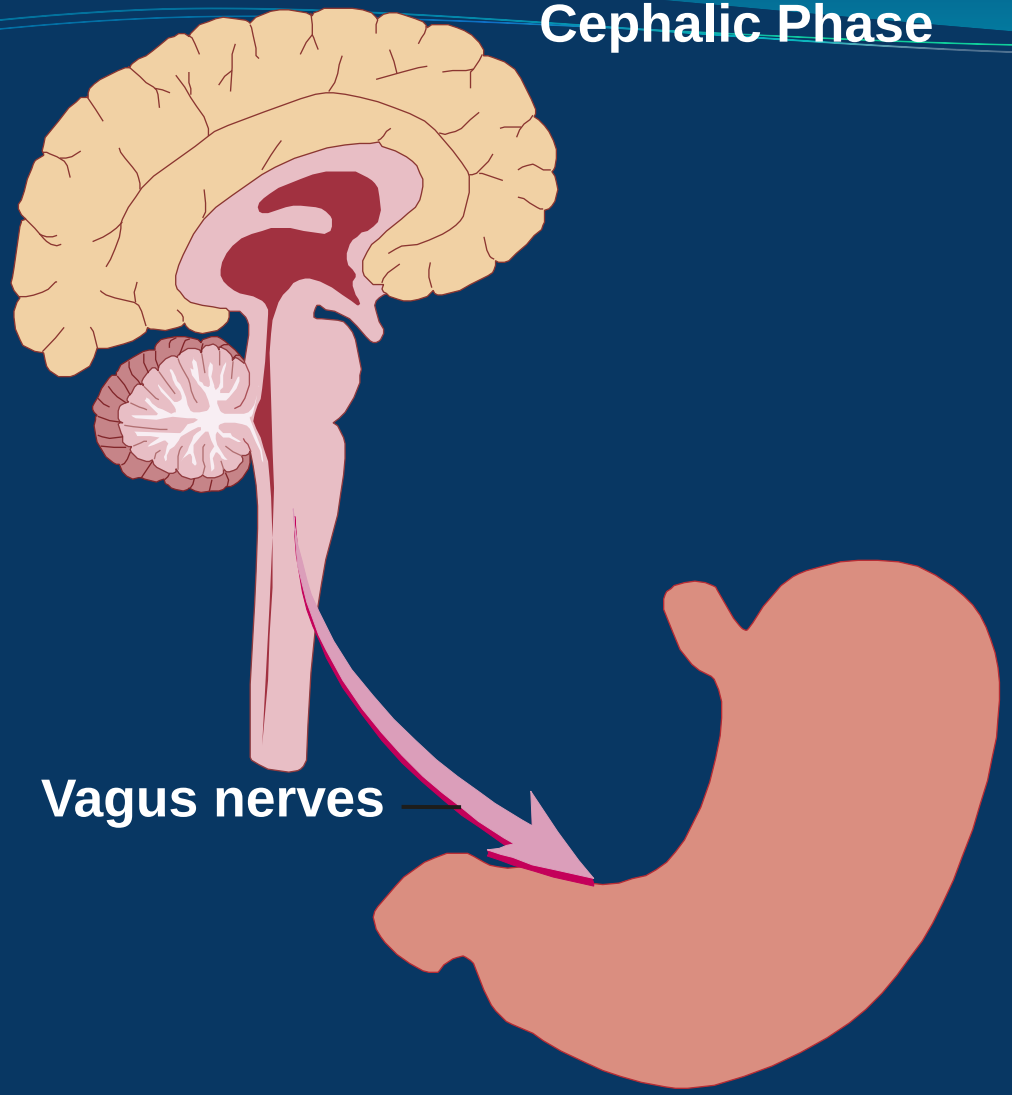
The taste or smell of food, tactile sensations of food in the mouth, or even thoughts of food stimulate the medulla oblongata (*green arrow*).

Cephalic Phase



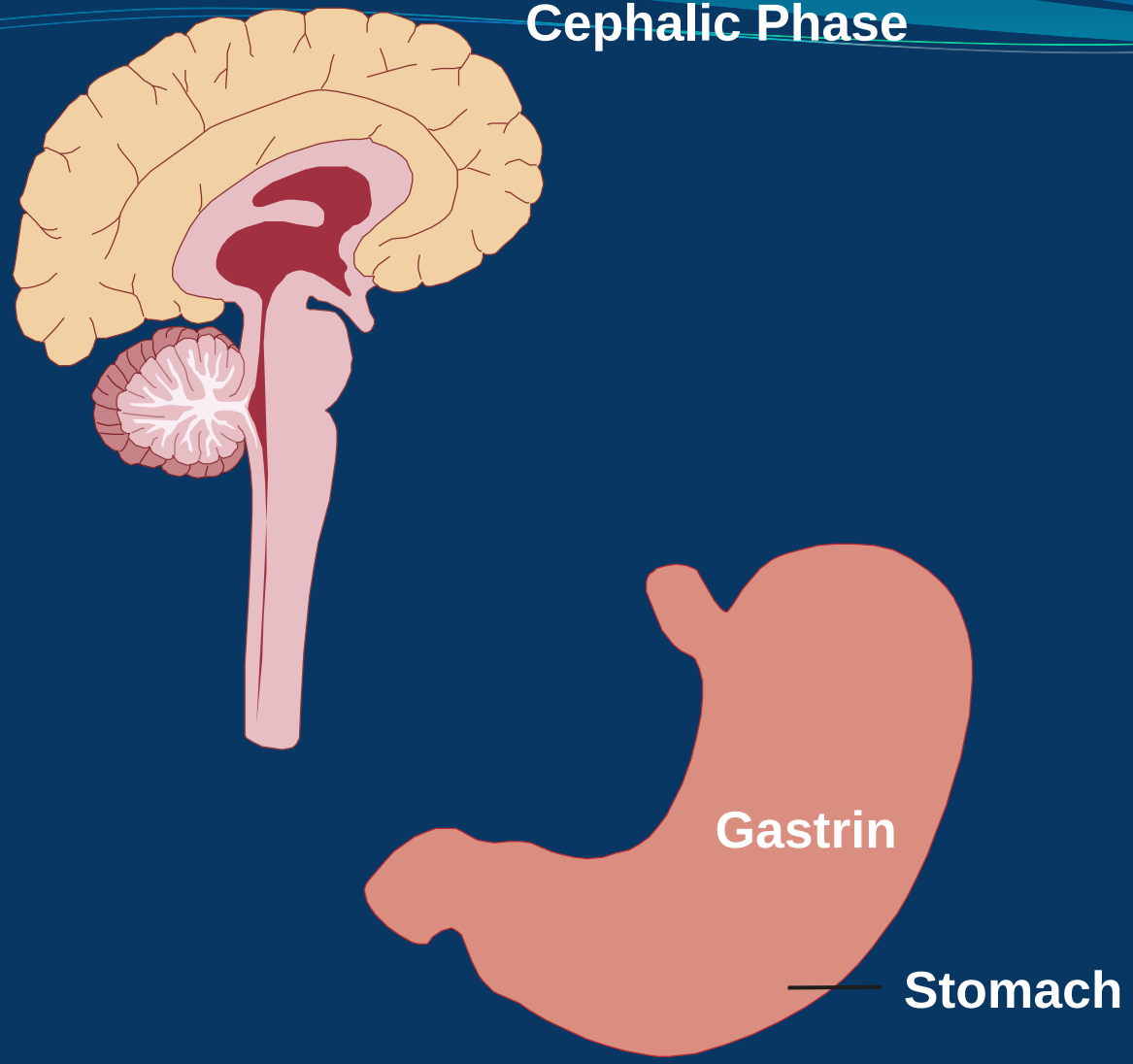
Parasympathetic action potentials are carried by the Vagus nerves to the stomach (*pink arrow*).

Cephalic Phase



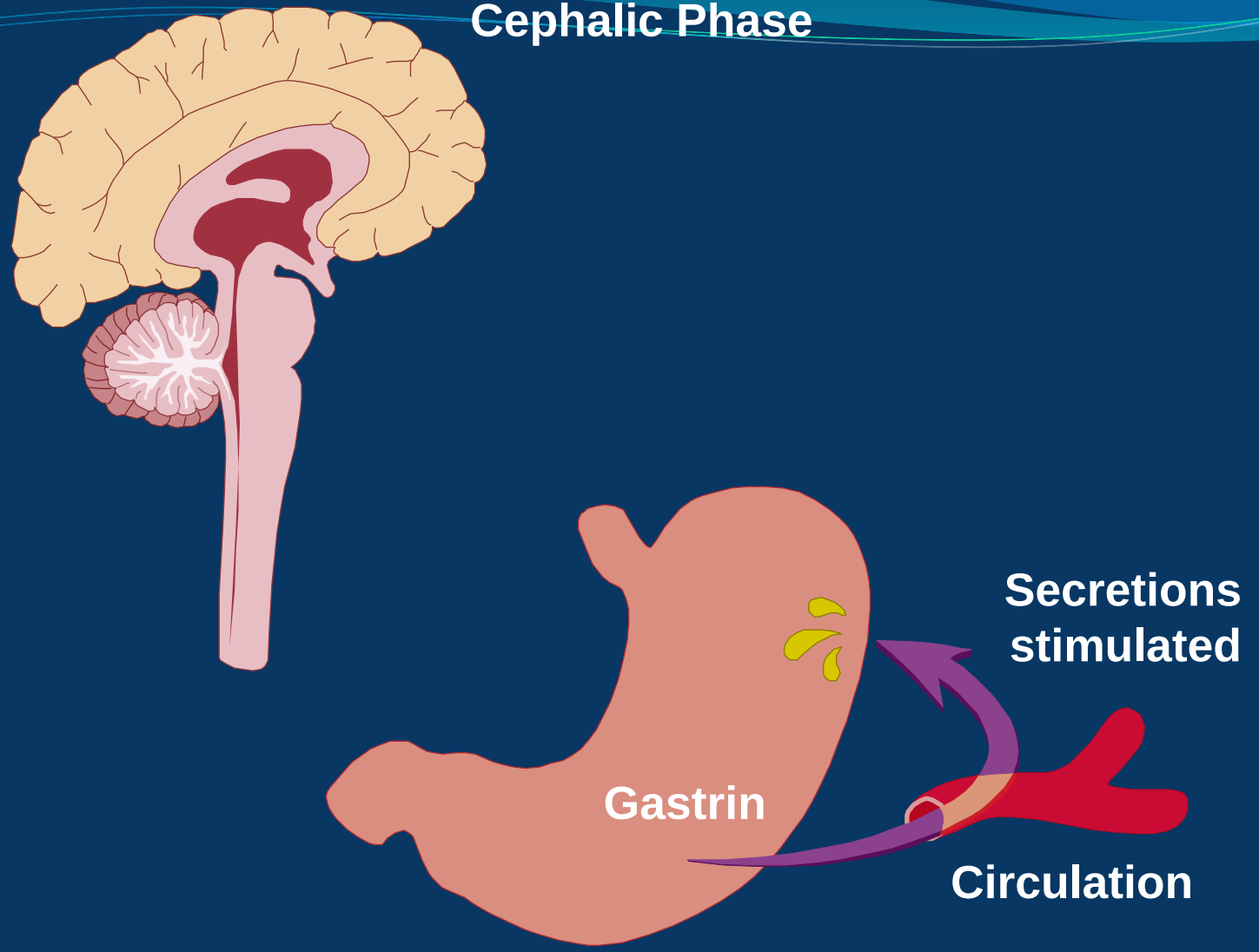
Preganglionic parasympathetic Vagus nerve fibers stimulate postganglionic neurons in the enteric plexus of the stomach.

Cephalic Phase



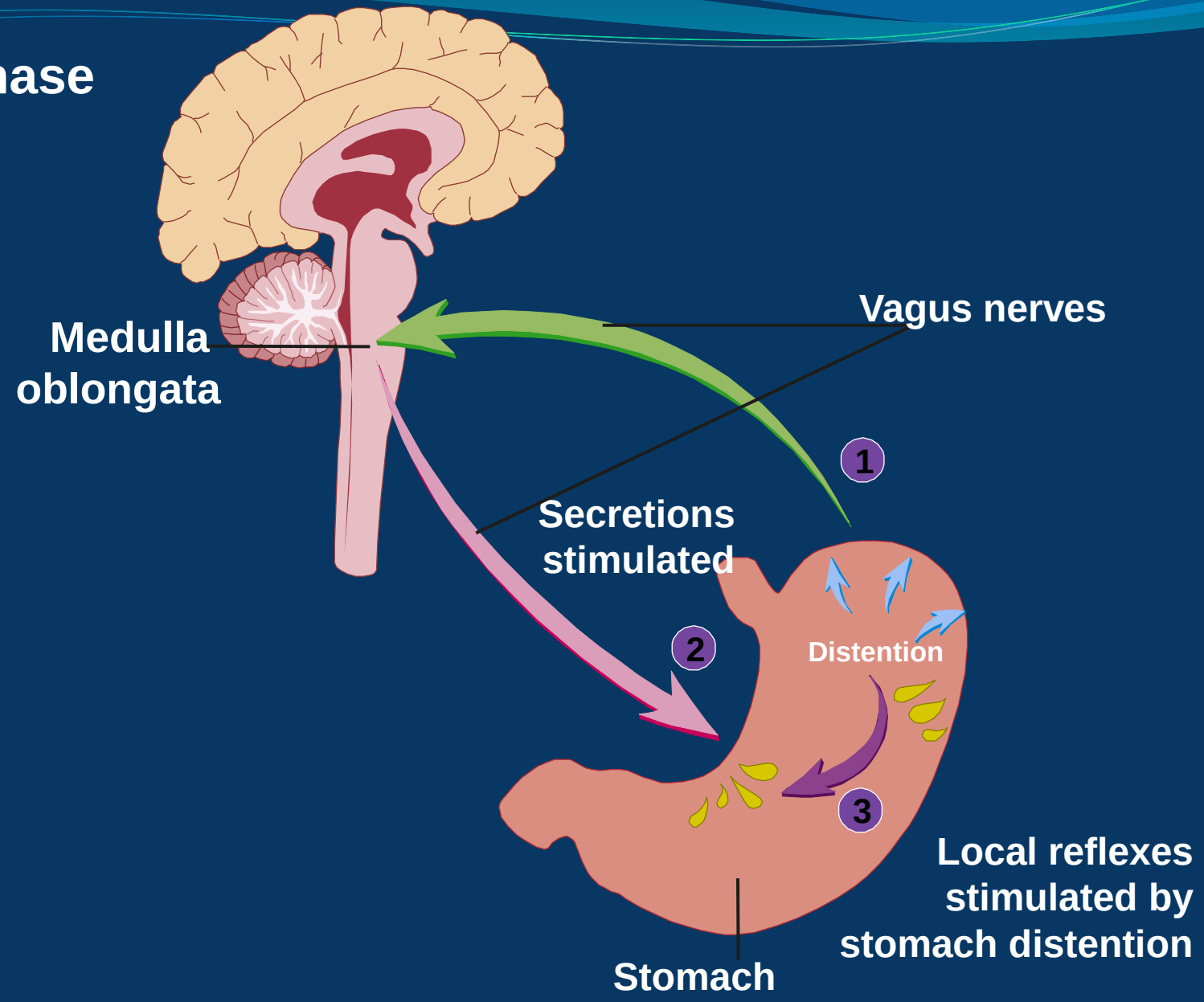
Postganglionic neurons stimulate secretion by parietal and chief cells and stimulate gastrin secretion by endocrine cells.

Cephalic Phase

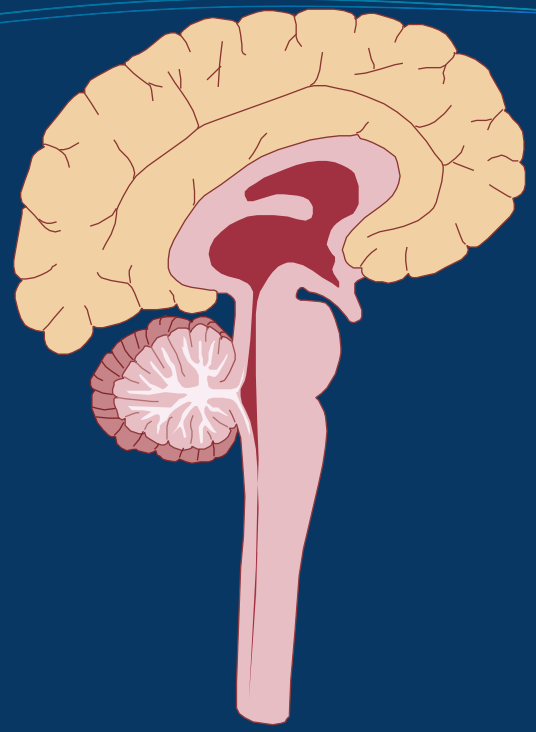


Gastrin is carried through the circulation back to the stomach (*purple arrow*), where it stimulates secretion by parietal and chief cells.

Gastric Phase



Intestinal Phase

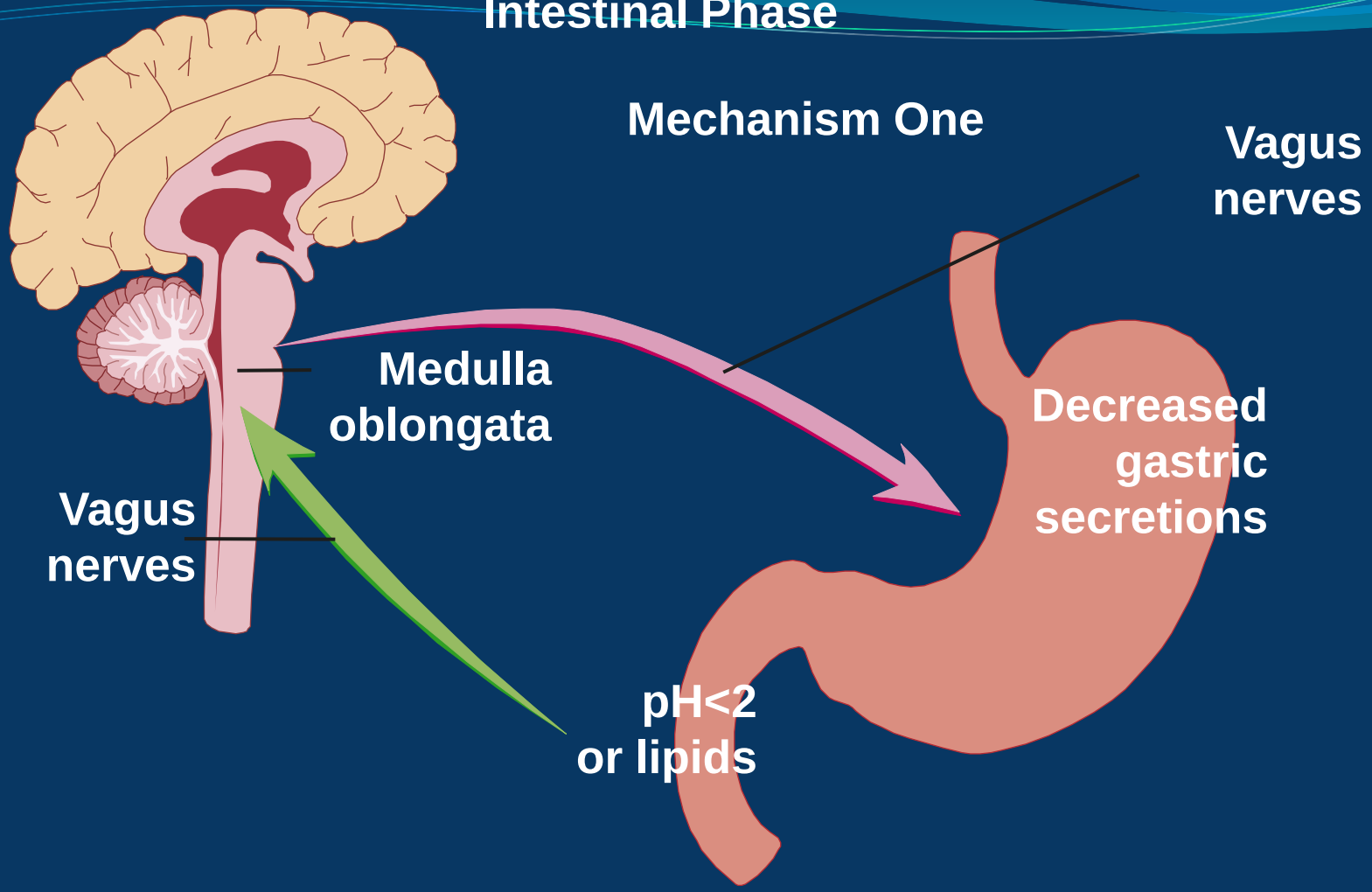


pH<2
or lipids

Chyme in the duodenum with a pH less than 2 or containing fat digestion products (lipids) inhibits gastric secretions by three mechanisms.

Intestinal Phase

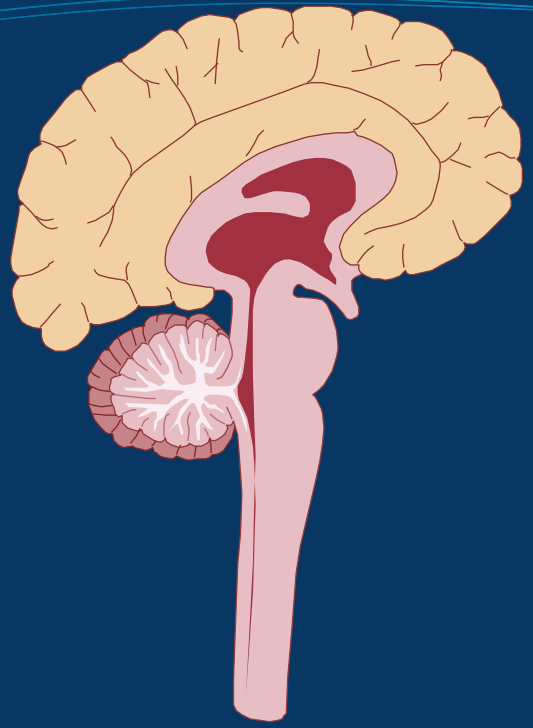
Mechanism One

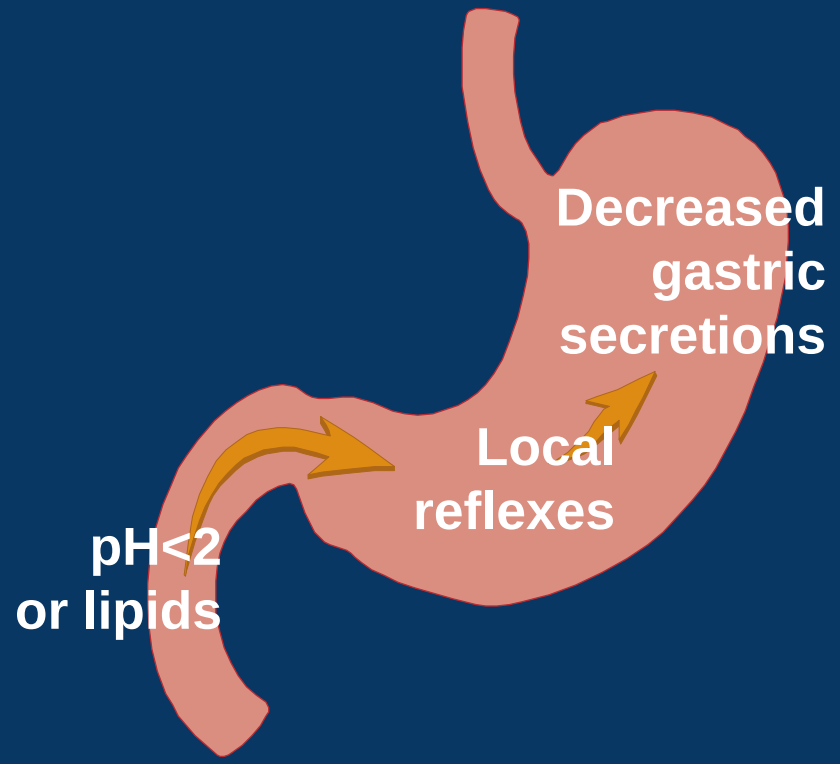


Sensory vagal action potentials to the medulla oblongata (*green arrow*) inhibit motor action potentials from the medulla oblongata (*pink arrow*).

Intestinal Phase

Mechanism Two

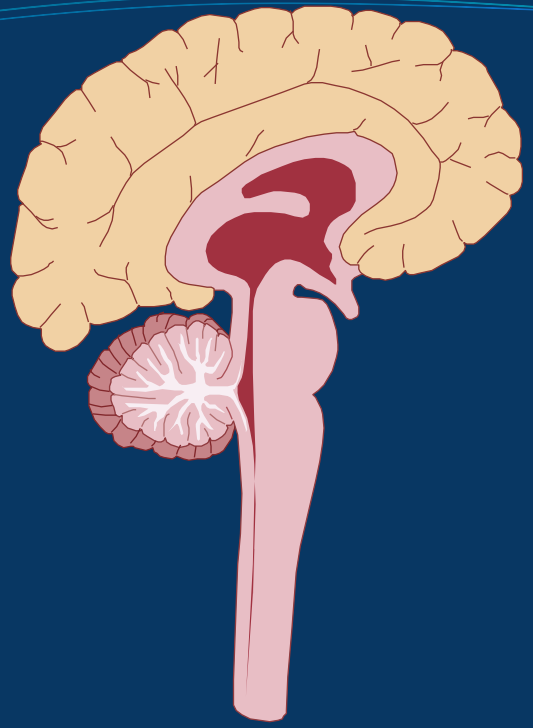


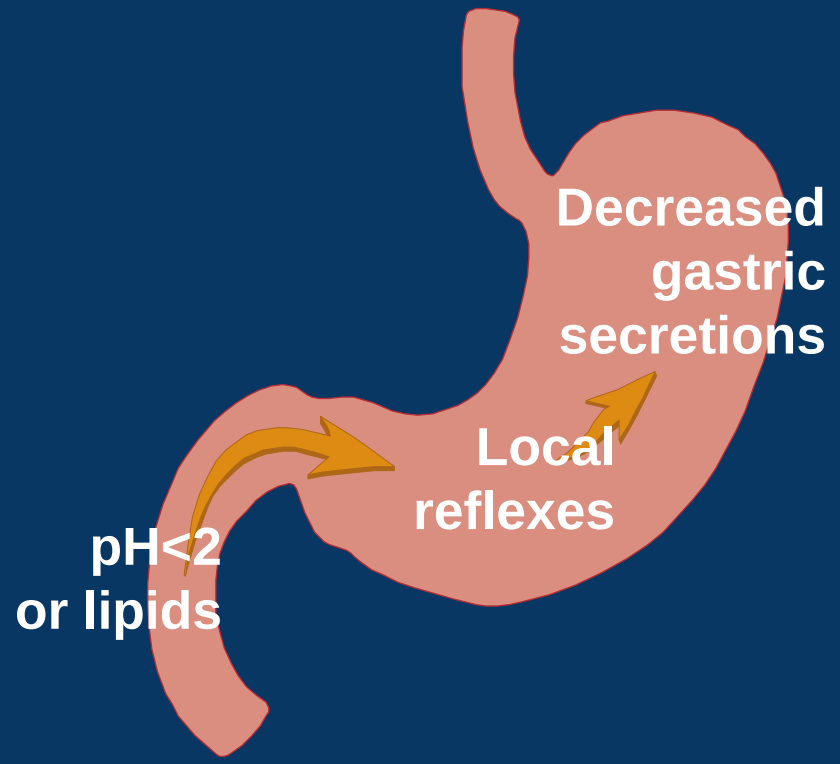


Local reflexes inhibit gastric secretion (*orange arrows*).

Intestinal Phase

Mechanism Two

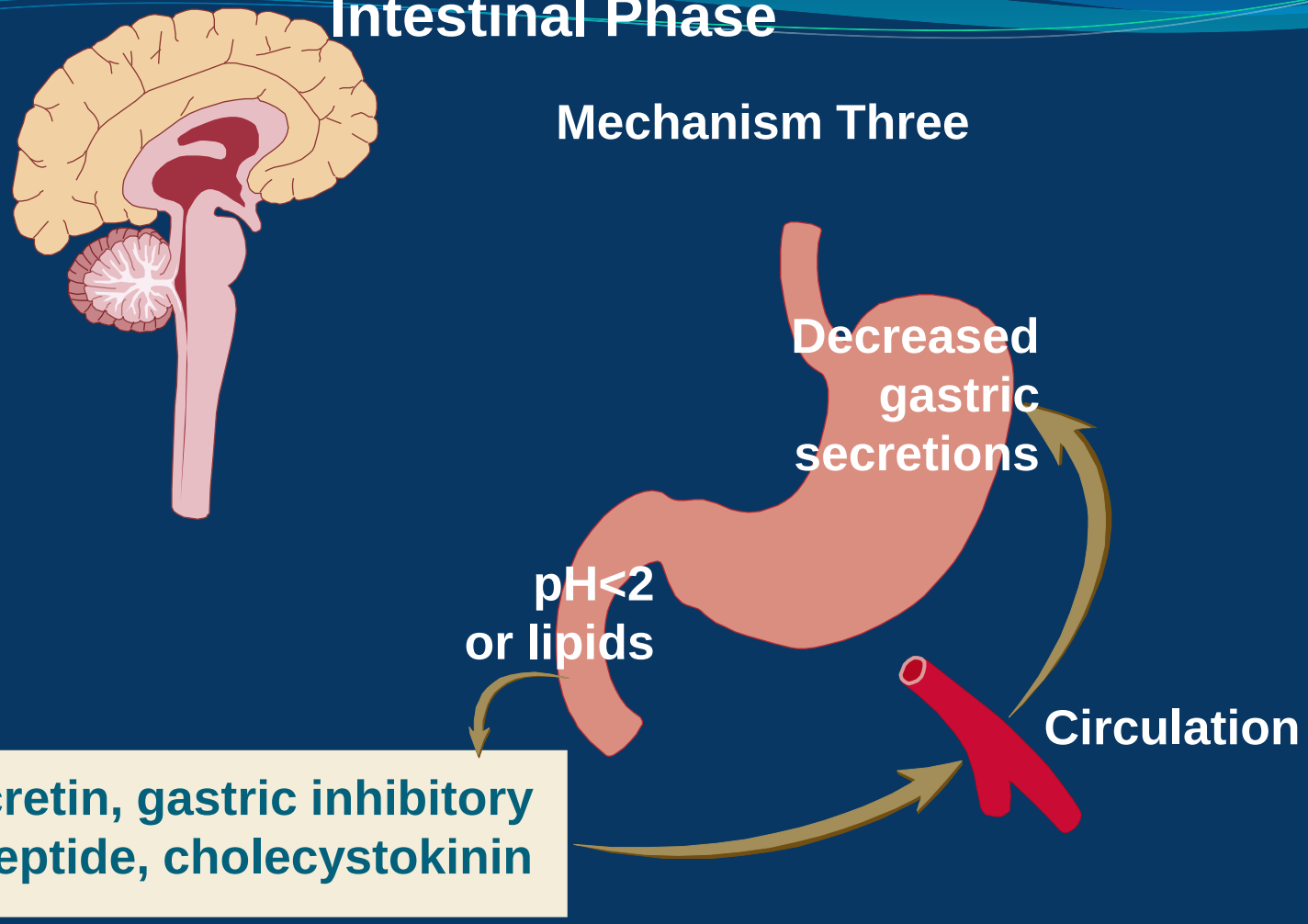




Local reflexes inhibit gastric secretion (*orange arrows*).

Intestinal Phase

Mechanism Three



Secretin, gastric inhibitory polypeptide, and cholecystokinin produced by the duodenum (*brown arrows*) inhibit gastric secretions in the stomach.


Thank You!