Lecture series
Gastrointestinal tract

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GASTROINTESTINAL MOTILITY-1

(*Deglutation and motor function of stomach)*

Mastication (Chewing)

- the anterior teeth (**incisors**) providing a strong cutting action and the posterior teeth (**molars**), a grinding action – **canine** tearing

- All the jaw muscles working together can close the teeth with a force as great as **25 Kg** on the incisors and **90 Kg** on the molars.

- Most of the muscles of chewing are innervated by the motor branch of the **5th cranial nerve**, and the chewing process is controlled by nuclei in the brain stem.

- Stimulation of areas in the **hypothalamus, amygdala, and even the cerebral cortex** near the sensory areas for taste and smell can often cause chewing

Chewing Reflex

- The presence of a **bolus of food in the mouth** at first initiates reflex inhibition of the muscles of mastication, which allows the *lower jaw to drop*.

↓

- The drop in turn initiates a **stretch reflex** of the jaw muscles that leads to rebound contraction

↓

- raises the jaw to cause closure of the teeth

↓

- **compresses the bolus again** against the linings of the mouth, which inhibits the jaw muscles once again

Chewing Reflex

- most fruits and raw vegetables because these have **indigestible cellulose membranes** around their nutrient portions that must be broken before the food can be digested

- Digestive enzymes act only **on the surfaces of food particles**

- **grinding** the food to a very fine particulate consistency prevents excoriation of the GIT (Stomach)

Swallowing (Deglutition)

- **Voluntary Stage** of Swallowing - squeezed or rolled posteriorly into the pharynx by **pressure of the tongue** upward and backward against the palate

- **Pharyngeal Stage** of Swallowing – stimulates epithelial swallowing receptor areas all around the opening of the pharynx

- The **soft palate is pulled upward** to close the posterior nares, to prevent reflux of food into the nasal cavities

- The **palatopharyngeal folds** on each side of the pharynx are **pulled medially** to approximate each other - form a ***sagittal slit*** through which the food must pass into the posterior pharynx

Pharyngeal Stage

- The **vocal cords** of the larynx are **strongly approximated**, and the larynx is pulled upward and anteriorly by the neck muscles**.**

- Presence of ligaments **prevent upward movement of the epiglottis**, cause the epiglottis to swing backward over the opening of the larynx**.**

- Prevent passage of food **into the nose and trachea.**

- The upward movement of the larynx also **pulls up and enlarges the opening to the esophagus.**

- At the same time, the upper 3 to 4 centimeters of the esophageal muscular wall, called **the upper esophageal sphincter relaxes**, thus allowing food to move easily and freely from the posterior pharynx into the upper esophagus

Pharyngeal Stage

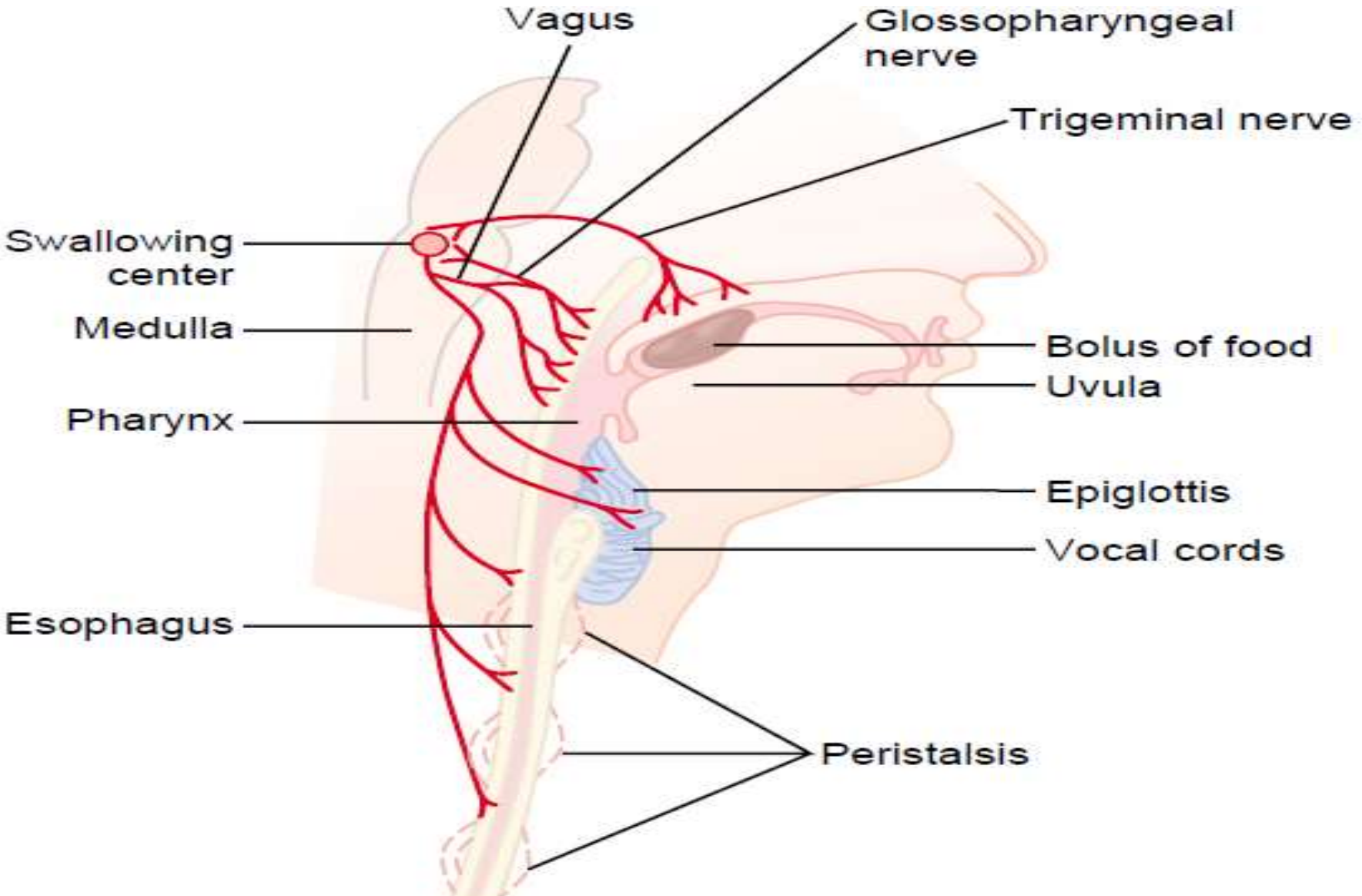
- **Between swallows**, upper esophageal sphincter remains **strongly contracted**, thereby preventing air from going into the esophagus during respiration

- Once the larynx is raised and the **pharyngoesophageal sphincter becomes relaxed**, the entire muscular wall of the pharynx contracts,

- First in the **superior** part of the pharynx, then spreading downward over the **middle and inferior** pharyngeal areas, which propels the food by peristalsis into the esophagus

- **less than 6 seconds**

Nervous Initiation of Pharyneal Stage of Swallowing



- Impulses are transmitted from **posterior mouth and pharynx** through the sensory portions of the 5^{th} & 9^{th} nerve into the **medulla oblongata –** NTS

- The successive stages of the swallowing process are then automatically initiated in orderly sequence by neuronal areas of the reticular substance of the medulla and lower portion of the pons.

- The areas in the **medulla and lower pons** that control swallowing are collectively called the ***deglutition or swallowing center***

- 5^{th},9^{th},10^{th} and 12^{th} cranial nerves

Pharyngeal Stage

- ***Deglutition apnea***

- Swallowing is difficult but not impossible when the mouth is open. A normal adult swallows frequently **while eating**, but swallowing also **continues between meals.**

- The total number of **swallows per day** is about 600:
- 200 while eating and drinking,
- 350 while awake without food,
- 50 while sleeping.

- Some **air** is unavoidably swallowed in the process of eating and drinking (**aerophagia**). Some of the swallowed air is **regurgitated (belching).**

Esophageal Stage

- **Esophageal Stage** of Swallowing - primary peristalsis and secondary peristalsis

- Primary peristalsis is simply **continuation of the peristaltic wave** that begins in the pharynx and spreads into the esophagus during the pharyngeal stage of swallowing - pharynx to the stomach in about 8 to 10 seconds

- 5 to 8 seconds, because of the additional effect of ***gravity***

Esophageal Stage

- **secondary peristaltic waves** result from distention of the esophagus itself by the ***retained food*** - continue until all the food has emptied into the Stomach

- Afferent – 10th nerve, Efferent – 9th, 10th nerve

- The musculature of the pharyngeal wall and upper one third of the esophagus is **striated muscle**

- In the lower two thirds of the esophagus, the musculature is **smooth muscle**

- even after **paralysis of the brain stem swallowing reflex**, food fed by tube or in some other way into the esophagus still passes readily into the stomach

- **Receptive Relaxation of the Stomach –**

  When the esophageal peristaltic wave approaches toward the stomach, a wave of *relaxation*, transmitted through myenteric inhibitory neurons, **precedes** the peristalsis.

- entire stomach and the duodenum become relaxed as peristaltic wave reaches the lower end of the esophagus - prepared ahead of time *to receive the food.*

- **Function of the lower Esophageal Sphincter (Gastro-esophageal Sphincter)**

  At the lower end of the esophagus, the **esophageal circular muscle** functions as a broad lower esophageal sphincter - the gastroesophageal sphincter

- LES normally **remains tonically constricted** in contrast to the midportion of the esophagus, which normally **remains relaxed**.

- When a peristaltic swallowing wave passes down the esophagus, there is "**receptive relaxation**" of the LES ahead of the peristaltic wave, which allows easy propulsion of the swallowed food into the stomach.

- ***The stomach*** secretions are **highly acidic** and contain many proteolytic enzymes. ***The esophageal mucosa***, except in the lower 1/8th of the esophagus, is not capable of resisting for long the digestive action of gastric secretions

Esophageal Stage

- the tonic constriction of the LES helps ***to prevent significant reflux*** of stomach contents into the esophagus except under very abnormal conditions

- Another factor that helps to prevent reflux is ***a valve like mechanism*** of a short portion of the esophagus that extends slightly into the stomach.

- Increased intra abdominal pressure yields the esophagus inward at this point - this valve like closure of the lower esophagus helps **to prevent high intra abdominal pressure from forcing stomach contents backward** into the esophagus.

- Otherwise, every time we walked, coughed, or breathed hard, we might expel stomach acid into the esophagus.

INTRODUCTION

TYPES OF MOTILITY IN GIT

A)PROPULSIVE/PERISTALSIS MOVEMENT

B) MIXING MOVEMENT

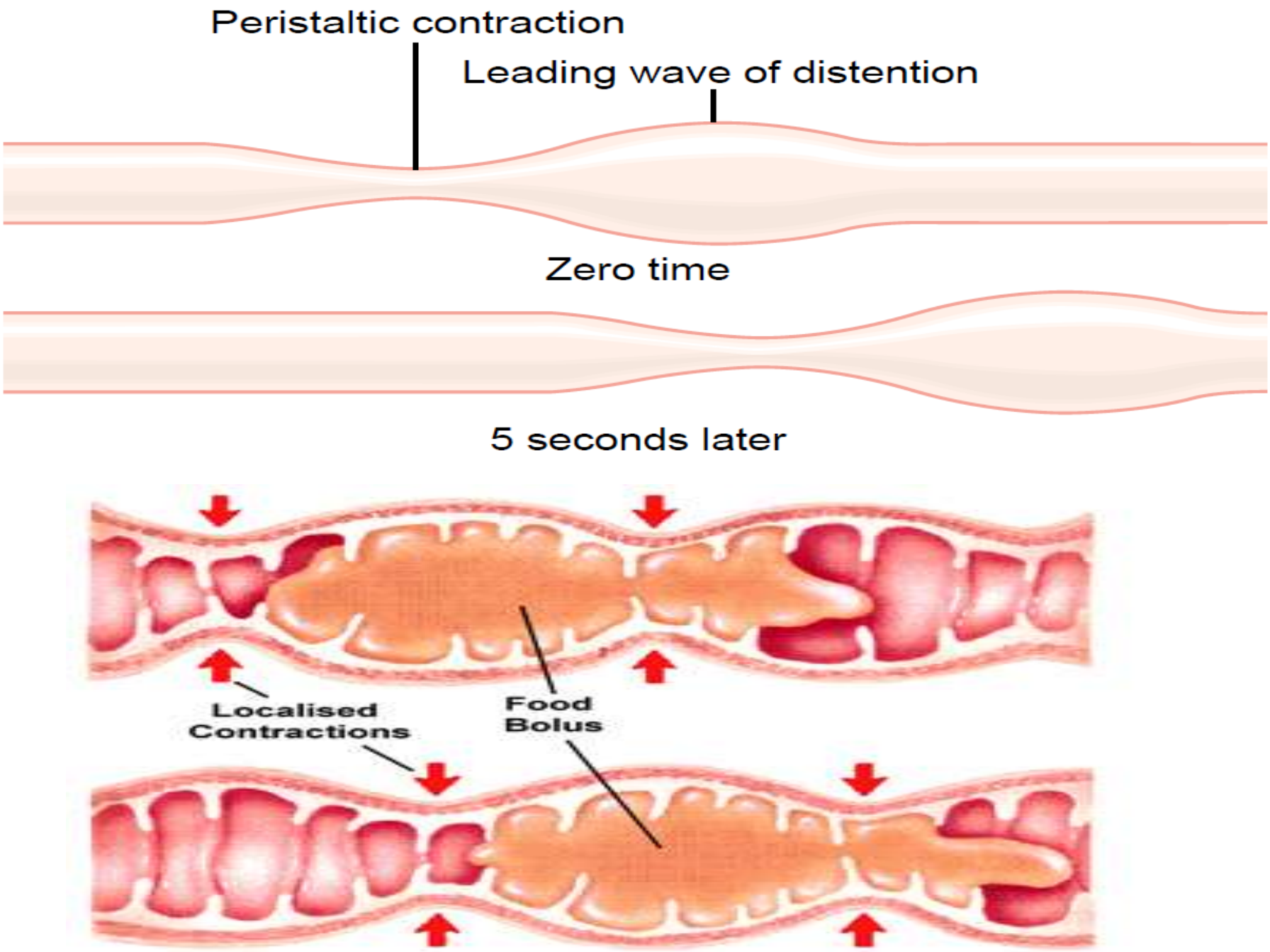
Movements in the GIT (Peristalsis)

- The basic ***propulsive*** movement of the GIT is ***peristalsis***

- **A contractile ring** appears around the gut and then moves forward - Any material **in front of** the contractile ring is moved forward

- **stimulation at any point** in the gut can cause a contractile ring to appear in the circular muscle, and this ring then spreads along the gut tube.

- Peristalsis also occurs in the **bile ducts, glandular ducts, ureters, and many other smooth muscle tubes** of the body


Peristaltic contraction
Leading wave of distention
Zero time
5 seconds later
Localised Contractions
Food Bolus

Peristalsis

- Peristalsis occurs only **weakly or not at all** in any portion of the GIT that has **congenital absence of the *myenteric plexus.***

- Also, it is greatly **depressed or completely blocked** in the entire gut when a person is treated with ***atropine*** to paralyze the cholinergic nerve endings of the myenteric plexus.

- Peristalsis normally **dies out rapidly in the oral direction** while continuing for a considerable distance toward the anus

- ***"Law of the Gut"*** **-** ***"Receptive relaxation"***
- *myenteric reflex or the peristaltic reflex

Peristalsis

- usual *stimulus* for intestinal peristalsis is ***distention of the gut***

- if a large amount of food collects at any point in the gut, the **stretching of the gut wall stimulates the enteric nervous system** to contract the gut wall 2 to 3 cm behind this point, and a contractile ring appears that initiates a peristaltic movement

- **chemical or physical irritation** of the epithelial lining of gut

- **strong parasympathetic** nervous signals

MIXING

- It is caused by local intermittent constrictive contraction occur every few centimeters in the gut wall

- This constriction promotes the chopping and shearing of the contents.

INTRODUCTION

MOTOR FUNCTION OF STOMACH

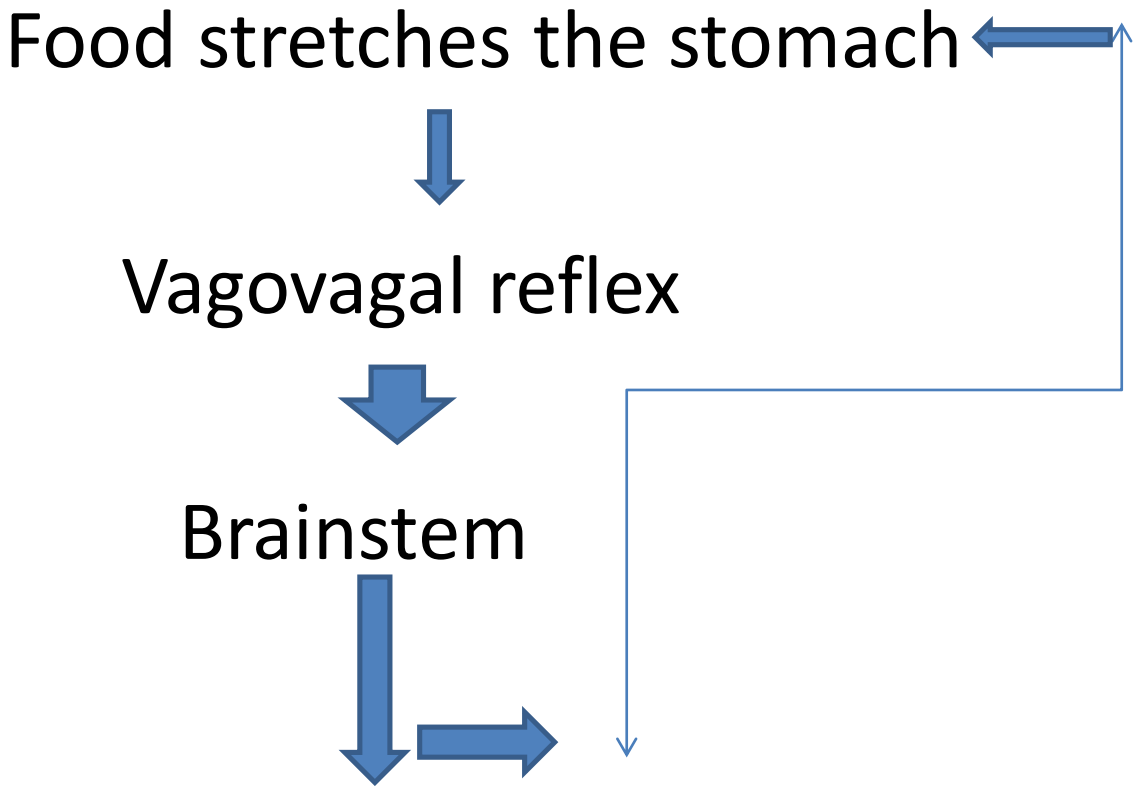
1) STORAGE

2)PERISTASIS

3)EMPTYING

1. STORAGE

As food enters the stomach,it form concentric circle of food in orad portion of the stomach



2.MIXING & PROPULSION OF FOOD

- Mixing wave begins in mid to upper portion of the stomach wall and moves towards the antrum,once in every 15-20secs.
- These waves are intiated by gut wall basic electrical rhythum called *slow wave*,occurs spontaneously in stomach wall
- Thes wave becomes greater from body to antrum
- After these retropulsive movement occur from antrum to body,these results in proper mixing of food with gastic secretion known as *chyme*

Stomach Emptying

- Most of the time, the rhythmical stomach contractions are weak and function mainly to cause **mixing of food and gastric secretions**

- For some time, **strong peristaltic, very tight ring like constrictions** that can cause stomach emptying

- These intense peristaltic contractions often create **50 to 70 centimeters of water pressure**, which is about **six times as powerful** as the usual mixing type of peristaltic waves.

- When pyloric tone is normal, each strong peristaltic wave forces up to **several milliliters of chyme into the Duodenum - *"pyloric pump."***

Stomach Emptying

- The pyloric **circular muscle** remains slightly tonically contracted almost all the time – thick walled - ***pyloric sphincter***

- the pylorus usually is ***open*** **for water and other fluids** to empty from the stomach into the duodenum **- prevents passage of food particles** until they have become mixed in the chyme to almost *fluid consistency*

- **Increased food volume** in the stomach promotes increased emptying from the stomach

- **stretching of the stomach wall** elicit local myenteric reflexes in the wall that greatly ↑ activity of the pyloric pump and at the same time inhibit the pyloric sphincter – ***no role of pressure***

Stomach Emptying

- **Gastrin** enhance the activity of the pyloric pump

- ***Enterogastric inhibitory reflexes*** from duodenum strongly *inhibit the "pyloric pump"* propulsive contractions, and *increase the tone* of the pyloric sphincter

- 1. The degree of **distention** of the duodenum
- 2. The presence of any degree of **irritation** of the duodenal mucosa
- 3. The degree of **acidity** of the duodenal chyme
- 4. The degree of **osmolality** of the chyme
- 5. The presence of certain **breakdown products** in the chyme, proteins and to a lesser extent of fats

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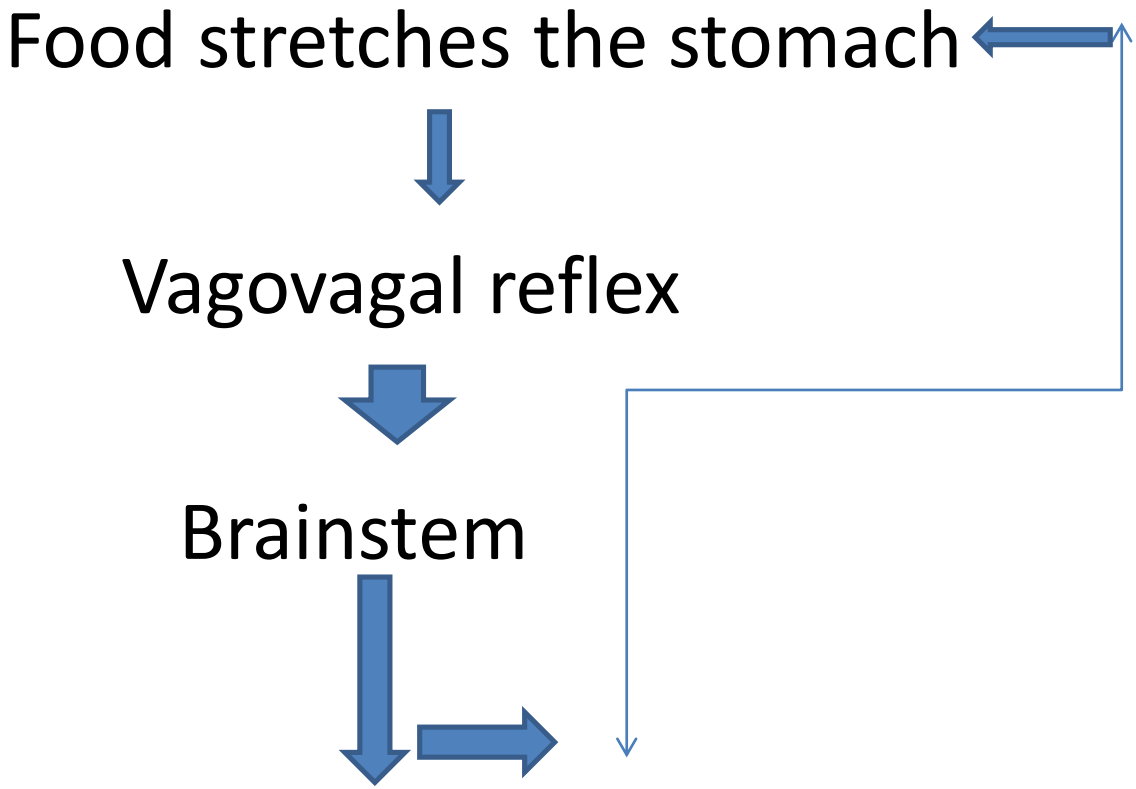

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Stomach Emptying

- On entering the duodenum, the ***fats*** extract several different hormones from the duodenal and jejunal epithelium, by **binding with "receptors"** on the epithelial cells

- hormones are carried by way of the blood to the stomach, where they **inhibit the pyloric pump** and at the same time **increase the strength of contraction of the pyloric sphincter**

- **cholecystokinin (CCK), secretin and gastric inhibitory peptide (GIP)**

- The rate at which the stomach empties into the duodenum depends on the **type of food** ingested. Food rich in **carbohydrate** leaves the stomach in a few hours. **Protein-rich** food leaves more slowly, and emptying is slowest after a meal **containing fat – fat and alcohol**

FACTORS REGULATING GASTRIC EMPTYING

Gastric factors that promotes empyting

A)Food- stretches stomach wall,activates myenteric reflexes,that accentuates pyloric pump & inhibit pyloric sphincter

B) Gastrin

Duodenal factors that inhibit emptying

A)Enterogastric nervous reflex

B)cholecytokinin

C) secretin

D) Gastrin inhibitory peptide

References

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