Note:-

- If the tone of LES is decreased (becomes incompetent) the gastric contents regurgitate into esophagus (gastro-esophageal reflux) causing heart burn.
- Tone of LES is increased by:- Gastrin, motilin, alpha adrenergic stimulation.
- Tone of LES is decreased by:-GIP, secretin, CCK, VIP, acetylcholine, β-adrenergic stimulation.

- **Swallowing reflex:-**
  - Receptor:- swallowing receptor areas at the pharyngeal opening.
  - Afferent:- 5,9,10 cranial nerves.
  - Center:- swallowing center in the medulla oblongata.
  - Efferent:- 5,9,10,11,12 cranial nerves.
  - Effector organ: muscles of swallowing

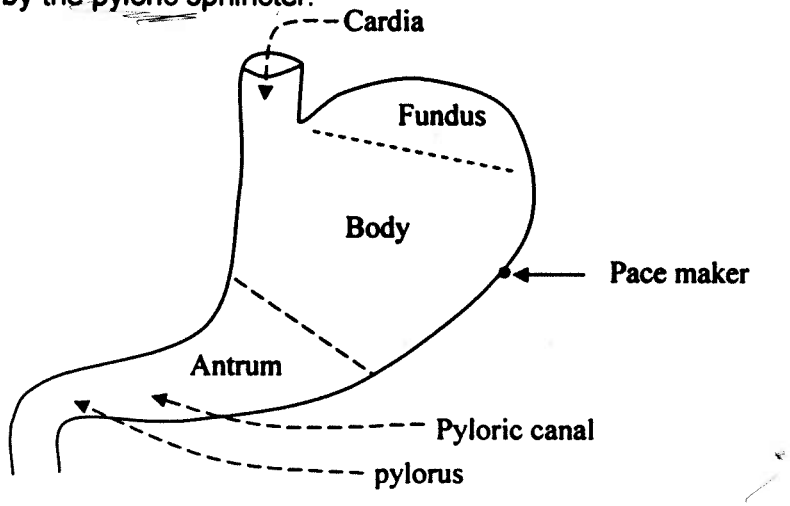
Note. Moderate amount of fluid must be present in mouth for swallowing to occur. It is impossible to swallow if the mouth is completely dry.

- **Swallowing disorders:-**
  1. **Dysphagia**:-
     - Definition:- Difficulty in swallowing.
     - Causes:- Lesion in the reflex arc of swallowing reflex either in the afferents, center efferents or effector organ (muscles of swallowing).
  2. **Achalasia (cardiospasm):-**
     - A condition in which the tone of LES is high, thus it fails to relax in front of peristaltic wave and food accumulate in lower part of esophagus leading to its dilatation.
     - Cause:- Absence of myentric plexus of esophagus or deficiency of VIP.

Gastric Motility

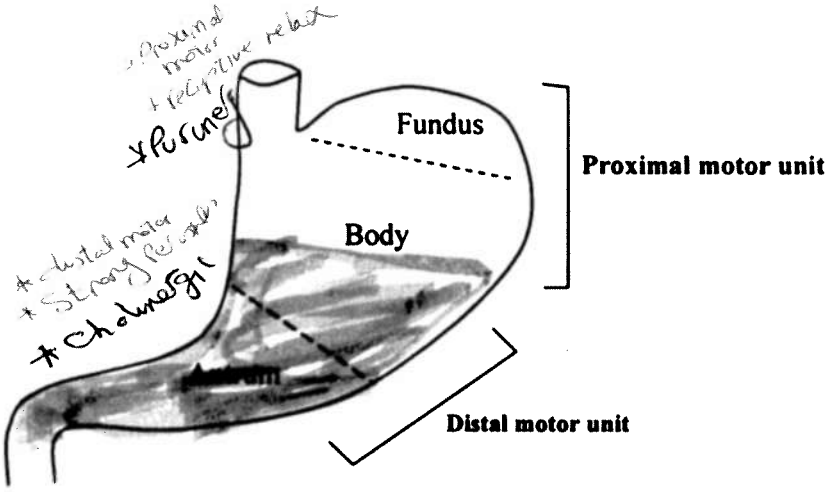
- **Motor functions of the stomach**:
  1. Storage of large quantities of food until the food can be processed in duodenum.
  2. Mixing of food with gastric secretions until it forms a semifluid mixture called chyme.
  3. Slow emptying of food from the stomach at a rate suitable for proper digestion and absorption in the small intestine.
- **Anatomically stomach is divided into 3 main parts**:-
  1. Fundus
  2. Body

3. Antrum (pyloric antrum):- continues as a short pyloric canal that ends by the pylorus (the opening of the stomach into duodenum) which is surrounded by the pyloric sphincter.



- **Physiologically** (functionally) stomach is divided into 2 main parts(units):

1. **Proximal motor unit**:-
   - Composed of fundus and first ⅔ of body of the stomach.
   - It has thin wall.
   - It **stores** food because it **shows mainly receptive relaxation** i.e. reflex relaxation of the proximal motor unit in response to swallowing and gastric distension. Such relaxation allows the stomach to accommodate up to 1.5 litters of food and fluids with only a little increase in intragastric pressure. It is mediated by vagal purinergic fibers (chemical transmitter is ATP) and sympathetic adrenergic fibers



2. **Distal motor unit**:-
   - Composed of the remainder of the stomach (last one third of body and antrum).
   - It has thick wall (thick muscles).
   - It **mixes** and **empties** food because it **shows strong peristalsis**. *This gastric peristalsis.*
     a. Starts at the midpoint of the greater curvature (pace maker of the stomach).
     b. At its start in the proximal motor unit it is slow and weak, but as it proceeds toward the antrum it becomes faster and stronger leading to:-
        1. mixing of food with gastric secretion forming the chyme.
        2. increasing the antral pressure more than duodenal pressure leading to emptying of gastric contents (Pyloric pump).
     c. It is caused by slow wave potential (slow gastric waves)(Basic electric rhythm)(BER) which starts at gastric pace maker at a rate 3-5 minute, some of them reach the firing level (-40 mV) leading to spike potential 3/minute. This action potential leads to peristalsis.
     d. It is stimulated by vagal cholinergic fibers and inhibited by sympathetic fibers.

- **Gastric emptying (evacuation):-**

Mechanism

- Most of the time gastric peristaltic contractions are weak and function mainly to mix the food with gastric secretion increasing the fluidity of chyme.
- However, about 20% of the time while the food in the stomach the peristaltic contractions becomes very strong leading to strong antral contractions which increase antral pressure forcing several millimeters of chyme into the duodenum each time (pyloric pump), the pylorus contract to prevent reflux.

Factors regulating (affecting) gastric emptying (evacuation):-

1- Food factors

a- Consistency of food:- Liquids are evacuated easily than solids.

b- Type of food:-
   - Carbohydrate rich food leave the stomach relatively rapid.
   - Protein rich food takes more time (slower) to be evacuated from stomach.
   - Fat rich food is the slowest to be evacuated from the stomach.

2- Gastric factors:- stimulate gastric emptying.

a- **Nervous:-** Gastric distension (within limits) increase the rate of gastric emptying by stimulating mechano-receptors in the wall of the stomach which initiate both vago-vagal and local enteric reflexes that stimulate gastric peristalsis in proportion to the degree of distension (up to a certain limit).

b- **Hormonal:-** Gastrin secreted from antral mucosa increase gastric emptying.

3. **Intestinal factors**:- Inhibit gastric emptying.

   a- **Nervous** (Enterogastric reflex):-

   Distension, increased acidity, hypersmolarity (and to less extent hypo-osmolarity) irritation and presence of fat in duodenum, stimulate different types of receptors in duodenal mucosa (mechano-receptors, chemo-receptors and osmo-receptors) leading local enteric and long (vago-vagal) reflexes that decrease rate of gastric emptying and ganglionic reflexes (the main mechanism). Enterogastric reflex is the most important factor that determine gastric emptying.

   b- **Hormonal:-** (enterogastrone):-

   The presence of excess fat in duodenum decreases gastric emptying through release of inhibitory hormones (GIP, CCK, secretin, motilin and VIP) which are collectively named entero-gastrone.

4. **Other factors**

   a- pain (somatic or visceral) leads to reflex inhibition of gastric emptying.

   b- Emotion:-1.Fear and depression usually slow gastric emptying
   2. Anger and anxiety accelerate gastric emptying.

   c-Chemical factors:-

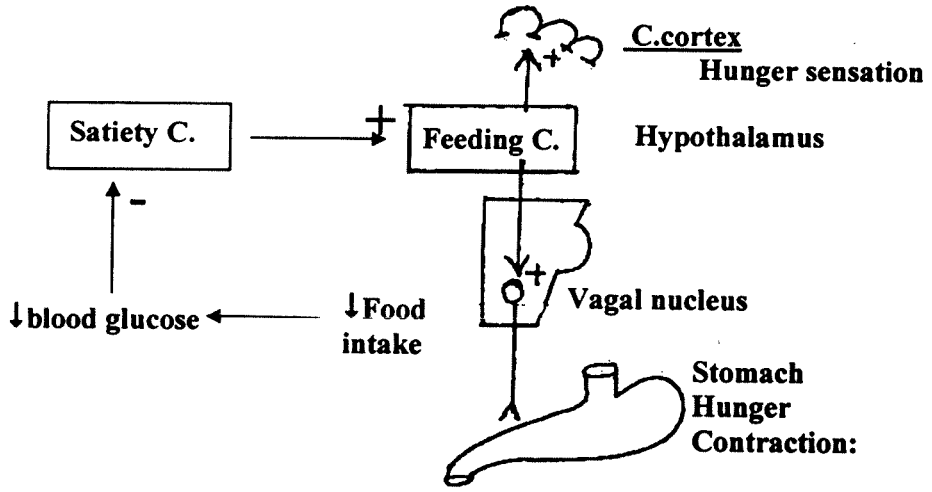
   1.Adrenergic drugs, atropine and excessive smoking decrease gastric emptying.

   2. Cholinergic drugs, bicarbonate and coffe accelerate gastric emptying.

- **Hunger contractions** (Hunger pain)

Definition

- These are intense rhythmic peristalsis that occur in the body of stomach when it is empty for long time (usually starts after 24 hours starvation reaches peak in 3-4 days then gradually decrease). Severely intense contraction, might be felt and might be mildly painful (hunger pain).



Mechanism (causes):-

- Feeding center in the hypothalamus is inhibited by impulses from satiety center (also in hypothalamus) when blood glucose is normal.
- ↓ blood glucose (as a result of food deprivation) stops the activity of satiety center, thus feeding center is released from the inhibitory effect of satiety center. Impulses from feeding center reach cerebral cortex leading to hunger sensation and reach vagal nucleus in the medulla leading to hunger contraction.

• Vomiting:-

° **Definition**: Expulsion of gastric contents to outside through the mouth.

° **Causes**:- It is due to stimulation of vomiting center in the medulla by

1- afferent impulses from GIT as in:-

a- Mechanical stimulation of the posterior part of the tongue or back of throat.

b- Irritation of gastric mucosa e.g. gastroenteritis.

c- Intestinal obstruction.

2- Afferent impulses from internal viscera e.g. visceral pain.

3- Afferent impulses from chemoreceptor trigger zone (CTZ) (An area in the medulla nearby vomiting center). CTZ is stimulated by:-

a- Drugs (emetic drugs) as morphine, apomorphine and digitalis.

b- Toxins in certain diseases e.g. kidney and liver failure.

c- Afferent impulses from cerebral cortex through conditioned reflexes (psychic vomiting)

d- Hypoxia e- Acidosis f- Motion sickness.

° **Mechanism:-** stimulation of vomiting center by one of the factors mentioned before leads to:-

1. Nausea, excessive salivation, sweating, pallor and tachycardia (before vomiting).
2. Protection of respiratory passages by:-
   a-Elevation of soft palate to close the nose.
   b-Closure of glottis mainly by approximation of vocal cords.
   c-Apnea.
3. Body of the stomach and lower esophageal sphincter relaxes completely.
4. Squeezing of gastric contents by strong contraction of the diaphragm and abdominal muscles leading to increased intra-abdominal pressure.

° **Effects of vomiting of gastric contents:-**

1. Dehydration leading to hypotension and tachycardia.
2. Alkalosis due to loss of acidic gastric contents.
3. Loss of electrolytes specially Na^+ and K^+

Movement of Small Intestine

- Basic electric rhythm (BER) (intestinal slow waves) varies between 12-9/ min. 12/min in duodenum and 9/min in ileum.
- **Types of movements**:-
  1. **Mixing movement** (segmenting movement or contraction):-
     - **Description**:- several constrictions divide a loop of intestine into equal parts, then disappear and are replaced by other constrictions between the previous constrictions. It occur at a frequency 9-12/min.
     - **Function**:
       1.Help digestion by mixing food with digestive enzymes.
       2.Help absorption by contact of food with wall of intestine.
     - **Control**:- Mainly myogenic (not nervous)(not abolished by blocking extrinsic nerves or local nerve plexuses).