Physiology (code)-year 2

Gastrointestinal tract (GIT)

Lecture 1 (Introduction , Motor Function of Mouth and Esophagus)

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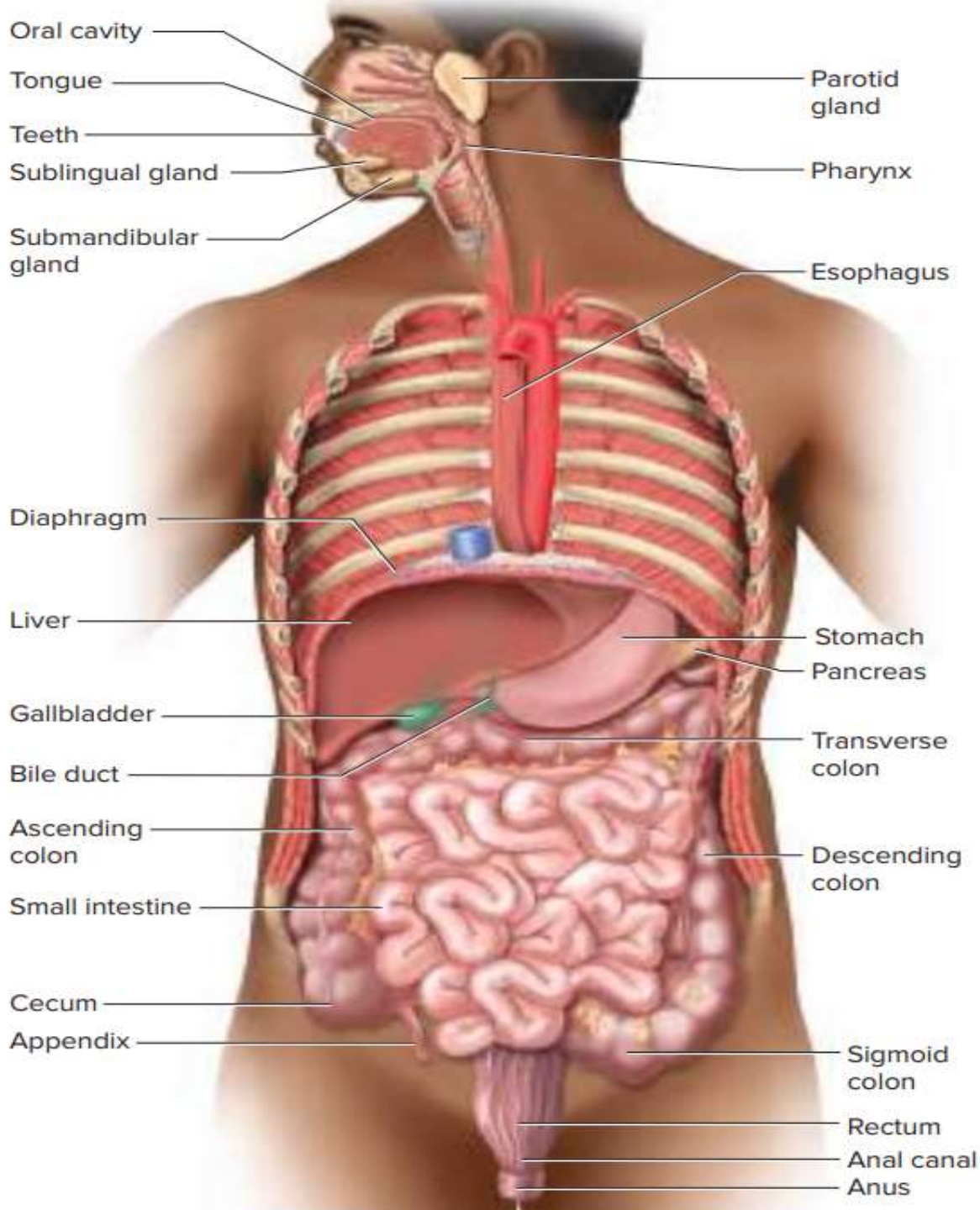
Objectives:

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

2.Describe hormonal families that control the functions of digestive system.

3.Describe the functions of the mouth and the esophagus and the control of that functions


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:

- Mucosa (The inner lining of the digestive tract)

  Epithelium

  Lamina propria (a loose connective tissue layer)

  Muscularis mucosae(a thin layer of smooth muscle)

- 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.

- Muscularis externa

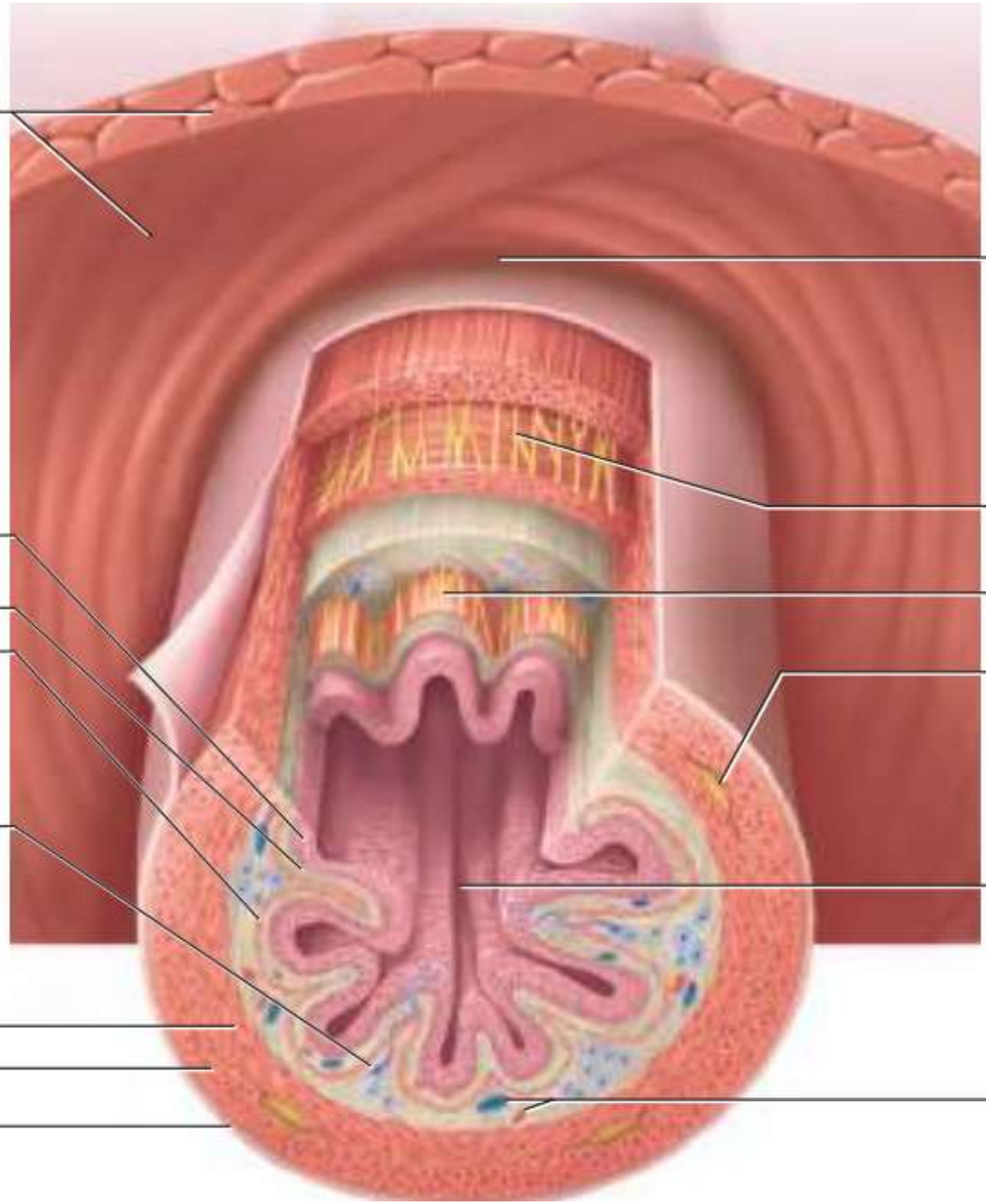
  Inner circular layer

  Outer longitudinal layer

- Serosa

  Areolar tissue

  Mesothelium


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

Control of GIT functions:

1. **Nervous control (control motility and secretion):**

a. Intrinsic control (local) specific for GIT, it is called enteric nervous system (ENS) which has neurons, nerve fibers, receptors and chemical transmitters.

•The enteric nervous system is composed of two layers of neurons and connecting fibers, the outer layer called the **myenteric (Auerbach,s) plexus** which controls mainly the GIT movement. The inner layer called the **submucous(Meissner's) plexus**, which is important in controlling secretion and blood flow and also subserves many sensory functions, receiving signals from the gut epithelium and from stretch receptors in the gut wall. All these plexuses are connected to each other in some way, and the plexus in the upper GIT are continuous with neurons plexus in lower GIT.

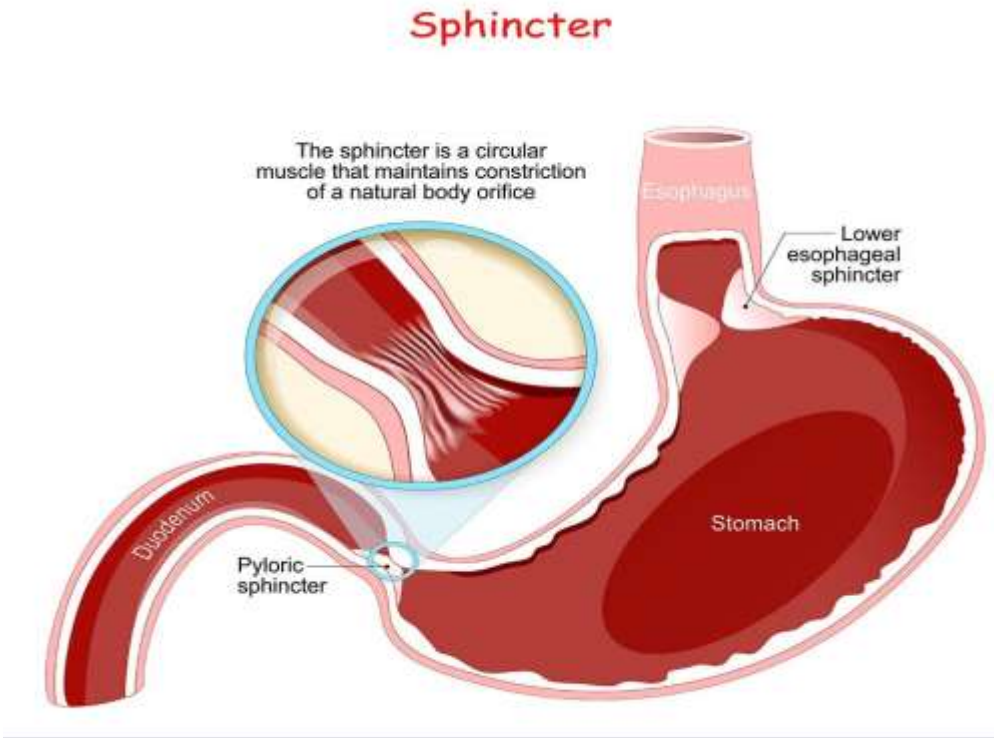
- The Meissner's plexus are usually attach to receptors in mucosa, these receptors are of 2 types (chemoreceptors :stimulated by chemical nature of food, and mechanoreceptors :stimulated by mechanical stimuli e.g. stretch and pressure)

- Chemical transmitters of GIT: The usual chemical transmitter is acetylcholine but in some neurons there are other transmitters (peptide in nature)→Glucagons, substance P (pain), and VIP (vasoactive intestinal polypeptide).

- If we remove all neurons from GIT except enteric nervous system, all parts of GIT with work normally.

- **b. Extrinsic control related to autonomic nervous system:**
- 1. Parasympathetic : supply to the gut is divided into cranial and sacral divisions. The cranial division is mediated almost entirely through the vagus. Vagus nerves innervate esophagus, stomach, little innervations to small intestine, pancreas, and first half of the large intestine. The sacral fibers originate in S2, S3 S4 sacral segments of the spinal cord, and supply the distal part of the large intestine.
- Stimulation of the fibers (parasympathetic) release acetylcholine and cause a general increase in the activity of the entire enteric nervous system which in turn enhances the activity of most GIT functions, and causing sphincters to relax, so they are stimulatory to GIT.

2. Sympathetic : The fibers originate in the spinal cord between the segmentsT8 and L2. Stimulation of the sympathetic nervous system inhibits activity in the GIT, causing sphincters to contract, they inhibit the secretion of acetylcholine, inhibit the motility and secretion, so they are inhibitory the GIT.



Humoral control (hormonal control):

- This is done through gastro intestinal hormones secreted from GIT mucosa including:
- 1.Gastrin hormone: It is polypeptide, released from antrum of the stomach by cells called G-cells. The main stimulus for its release is the presence of food in the stomach. Food in the stomach → stretch the stomach → stimulate mechanoreceptor and chemical materials in the food →stimulate chemoreceptor s → gastrin secretion
- 2.Action of gastrin:
- 1. Increases gastric motility and secretion.
- 2. Closing the lower esophageal sphincter (between esophagus and stomach).
- 3. Increases small intestinal motility →gastro-enteric reflex.
- 4. Increases large intestinal motility →gastro-colic reflex.
- 5. Relaxes pyloric sphincter.

3.Cholecystokinin-pancreazymin (CCK-PZ):

.Released by mucosa of upper part of small intestine, mainly the duodenum.

.Main stimulus for its release is the presence of fat in the duodenum.

Actions:

1. Decreases the secretion and motility of stomach, so delays digestion of food (delays the feeling of hunger).
2. Contract the gall bladder and causes release of bile.
3. Stimulates the pancreatic exocrine secretion (secretion of digestive enzymes).

3.Secretin:

•Released from mucosa of upper small intestine, mainly the duodenum.

•Stimulus for secretion: acid in duodenum.

•Actions:

1. ↓ Gastric secretion and emptying.

2. ↑ Pancreatic exocrine secretion (HCO_3^-).

4.Gastric inhibitory peptide (GIP) :

- •Released from duodenum.
- •Stimulus for secretion: acid and fat in duodenum.
- •Actions: Inhibits gastric secretion and emptying .

The movement of GIT (GIT motility): There are 2 types of movements in GIT:

1. Mixing movement: local mix the food with secretion in GIT, done by visceral smooth muscle of the organ.
2. Propulsive movement: push the food from one part of GIT to the other. It is also called peristalsis.

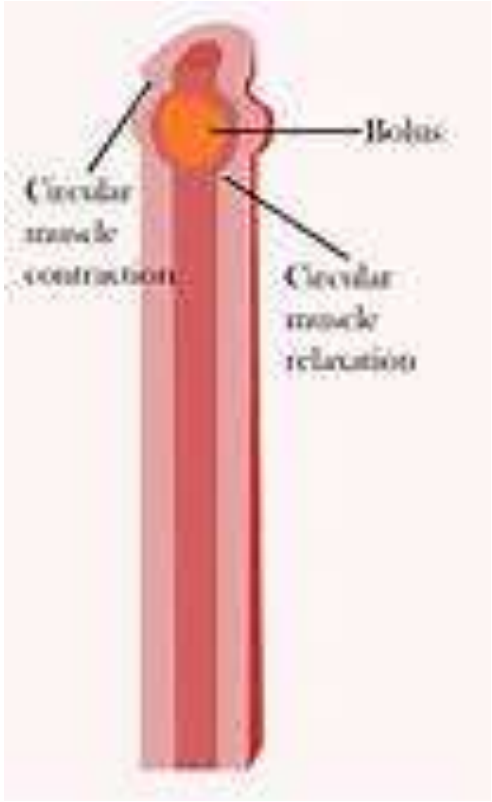
It is due to contraction of the smooth muscle and it's not unique for GIT it is also occurs in other organs like ureters.

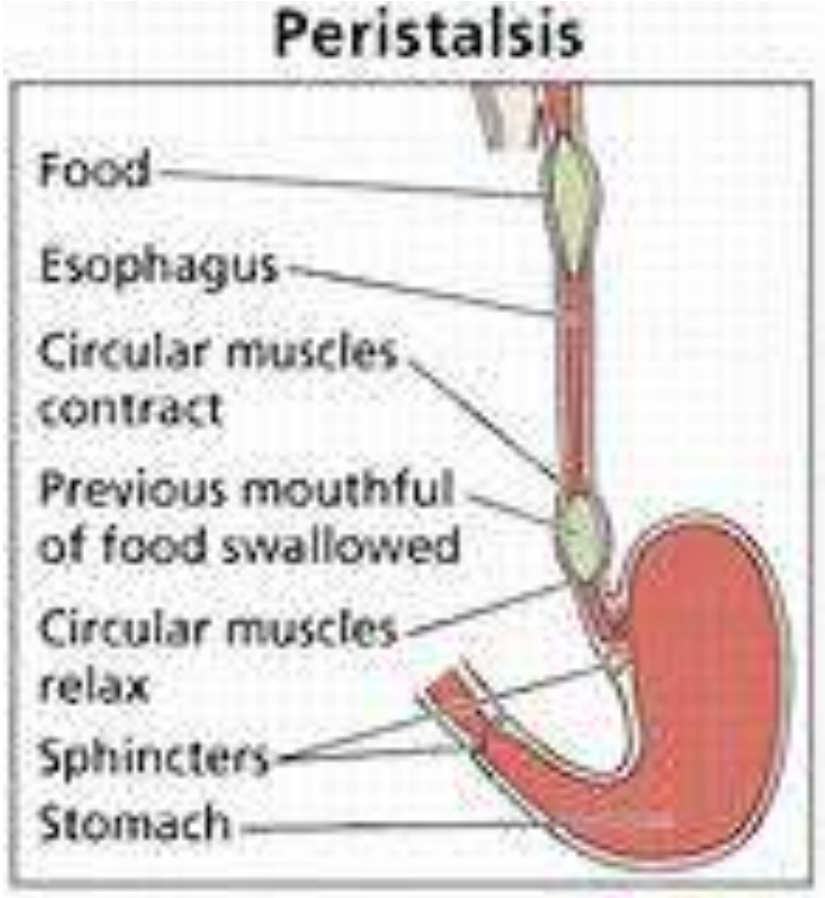
•Peristalsis has one direction of movement called oral to caudal direction (oral to rectal) while in abnormal conditions e.g. vomiting, the direction will be reversed (opposite).

•The stimulus for peristalsis is distention of lumen of GIT by food (or other material even a foreign body). This distention is going to stimulate the mechanoreceptor which will send impulse to Myenteric nerve plexus which will initiates peristalsis.

The area behind the distention will contract due to release of acetylcholine and substance P while the area after (in front of) the distention will relax due to the release of vaso-active intestinal polypeptide (VIP). This is called the law of gut.

The area in front of distention is going to do receptor relaxation so food will move from oral to caudal end, and food will move to the relaxed area





•Peristalsis in intestine need intact and integrated regularly distributed Myenteric nerve plexus. If any part of GIT is removed then re-sutured in opposite side → no peristalsis.

•Peristalsis is due to local Myenteric nerve plexus and it is controlled by extrinsic nerve system (sympathetic → inhibitory, parasympathetic → stimulatory).

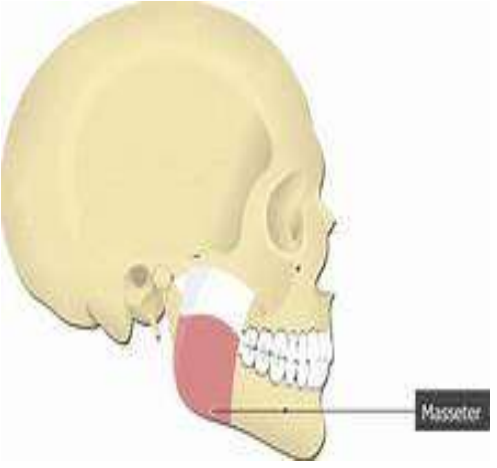
•In vomiting the peristalsis is reversed and this is done by extrinsic nervous system.

Mouth

It is important for chewing of food and mastication. Food will be destroyed into small particles and this increases the surface area of food exposed to secretion. This is under the control of extrinsic nervous system and it is usually done by trigeminal and facial nerves

Chewing

started voluntary but it will continue automatically by automatic reflex because when food touch the roof of the mouth → reflex inhibition of masseter muscle → drop of mandible → stretch of masseter muscle → reflex contraction of master muscles → food will touch the roof of the mouth again…. .



The chewing center is located in the medulla oblongata.

The importance of chewing are:

1. Breaks down the indigestible cellulose membranes around the nutrient portions of food

2. Increase the surface area of food so the rate of digestion of food by digestive enzymes is increase.

3. Mixes the food with salivary secretions, which initiates the process of starch digestion(by salivary amylase) and lipid digestion(by lingual lipase) and lubricate and soften the bolus of food, making it easier to swallow.

4. Brings food into contact with taste receptors and releases odors that stimulate the olfactory receptors, which lead to increase the pleasure of eating and initiate gastric secretions.

Swallowing (deglutition): Swallowing is a complicated mechanism because the pharynx most of the time subserves other functions (e.g. respiration). Swallowing can be divided into:

1. **Voluntary (oral) phase**: it is done by the tongue . Thus the tongue forces the bolus of food into the pharynx. Then the second stage started.
2. **Involuntary (pharyngeal) phase:** swallowing receptors located around the opening of the pharynx (stimulated by food)→ impulses transmitted by sensory division of trigeminal and glossopharyngeal nerves → swallowing centre (medulla oblongata and lower portion of pons) → motor impulses to pharynx and upper esophagus that cause swallowing are transmitted by 5th(trigeminal N), 9 th (glossopharyngeal N),

10th(vagus N), and 12th(hypoglossal N) cranial nerves and even a few of the superior cervical nerves) → series of automatic pharyngeal muscular contractions. The swallowing centre specifically inhibits the respiratory center of the medulla during swallowing, halting respiration at any point in it is cycle to allow swallowing to proceed. The sequence of events of the pharyngeal stage of the swallowing are as follows:

•The soft palate is pulled upward to close the posterior nares and preventing reflex of food into the nasal cavities.

The vocal cords of the larynx are strongly approximated and epiglottis swing backward over the superior opening of the larynx prevent passage of food into the trachea.

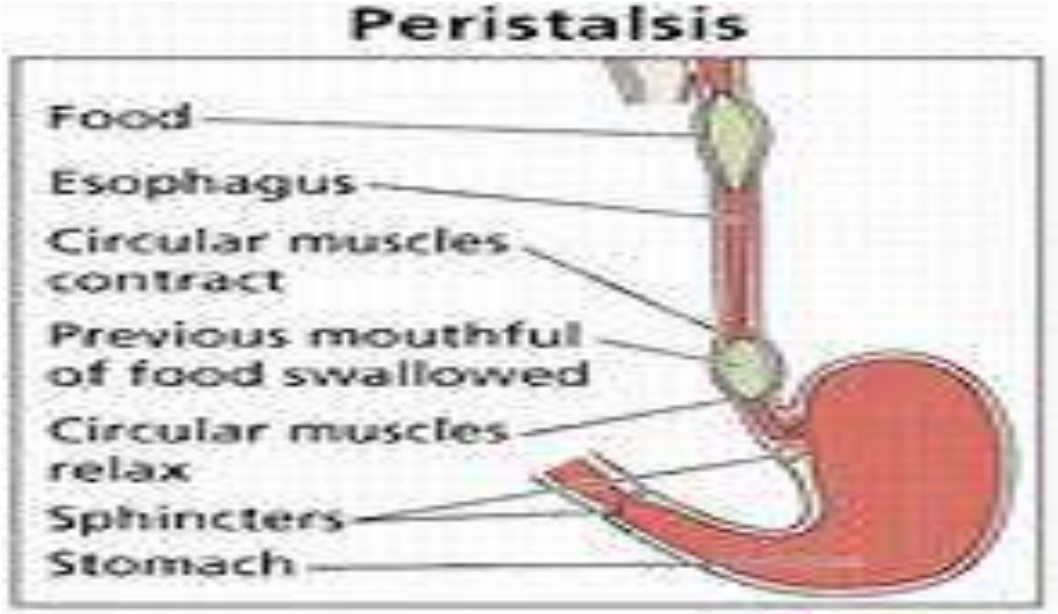
The superior constrictor muscle of the pharynx contracts, giving rise to rapid peristaltic wave passing downward over the middle and inferior pharyngeal muscles and into the esophagus, which propels the food into the esophagus.

3. Esophageal stage of swallowing: The esophagus functions to conduct food from the pharynx to the stomach. Esophagus exhibits two types of peristaltic movements

•**Primary peristalsis** which a continuation of the peristaltic wave that begins in the pharynx which passes all the way from the pharynx to the stomach through esophagus. The peristaltic waves of the esophagus are initiated by vagal reflexes. These reflexes are transmitted through vagal afferent fibers from the esophagus to the medulla and then back again to the esophagus through vagal efferent fibers.

- Secondary peristalsis:

  which is generated by the ENS of the esophagus itself, initiated from distension of the esophagus by the retained food if the primary peristalsis fails to move all the food that has entered the esophagus into the stomach.



- Receptive relaxation of the stomach:

  As the esophageal peristaltic wave passes toward the stomach,

 the gastroesophageal sphincter, the entire stomach and to lesser extent even the duodenum become relaxed as this wave reaches the lower end of the esophagus.


ADAM
Swallowing

Q1)How to prevent reflux of the acidic contents of the stomach up to the esophagus which may cause a damage to esophageal mucosa?

Thank You