

PHYSIOLOGY

GI MOTILITY

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GI Motility

DEGLUTITION

- process in the human or animal body that makes something pass from the mouth, to the pharynx, and into the esophagus, while shutting the epiglottis.
- If the process fails and the material goes through the trachea then choking or pulmonary aspiration can occur. In the human body the automatic temporary closing of the epiglottis is controlled by the swallowing reflex.
- The portion of food, drink, or other material that will move through the neck in one swallow is called a bolus.

- ORAL PHASE
- 1) **Moistening**
- Food is moistened by saliva from the salivary glands.
- 2) **Mastication**
- Food is mechanically broken down by the action of the teeth controlled by the muscles of mastication (V_3) acting on the temporomandibular joint. This results in a bolus which is moved from one side of the oral cavity to the other by the tongue

3) Trough formation

- A trough is then formed at the back of the tongue by the intrinsic muscles

4) Movement of the bolus posteriorly

- At the end of the oral preparatory phase, the food bolus has been formed and is ready to be propelled posteriorly into the pharynx.

- Once the bolus reaches the palatoglossal arch of the oropharynx, the pharyngeal phase, which is reflex and involuntary, then begins

- PHARYNGEAL PHASE

5) **Closure of the nasopharynx**

6) **The pharynx prepares to receive the bolus**

7) **Opening of the auditory tube**-the closure of the nasopharynx and elevation of the pharynx opens the auditory tube, which equalises the pressure between the nasopharynx and the middle ear. This does not contribute to swallowing, but happens as a consequence of it.

8) Closure of the oropharynx

9) Laryngeal closure

- It is true vocal fold closure that is the primary laryngopharyngeal protective mechanism to prevent aspiration during swallowing.

10) Hyoid elevation

11) Bolus transits pharynx

- The bolus moves down towards the esophagus by pharyngeal peristalsis which takes place by sequential contraction of the superior, middle and inferior pharyngeal constrictor muscles

OESOPHAGAL PHASE

12) Esophageal peristalsis

- Esophageal phase of swallowing is under involuntary neuromuscular control.
- propagation of the food bolus is significantly slower than in the pharynx. The bolus enters the esophagus ,propelled downwards first by striated muscle & smooth muscle

13) Relaxation phase

- Finally the larynx and pharynx move down with the hyoid mostly by elastic recoil

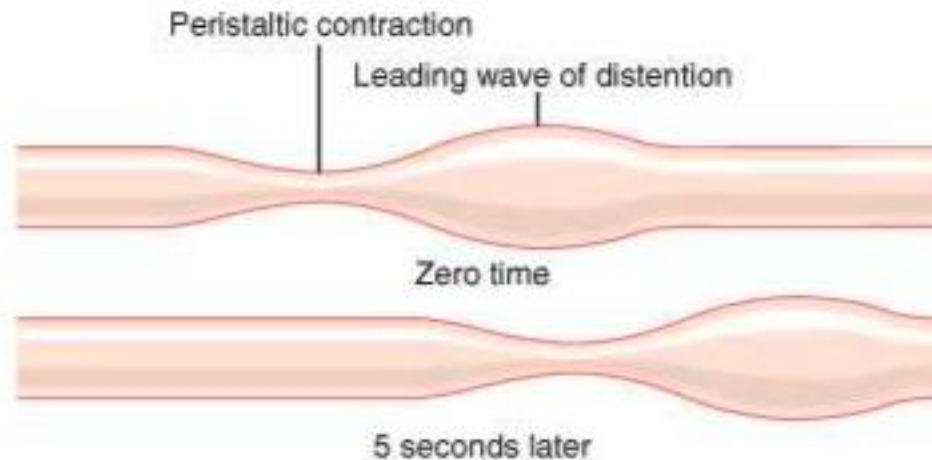
GI Motility

- 2 Types of movement in the GI tract.
 1. Propulsive movement of food forward at an appropriate rate for digestion and absorption.
 2. Mixing movements – caused by peristalsis and local intermittent contractions.

Peristalsis

- The propulsive movement in the GI is achieved by peristalsis.

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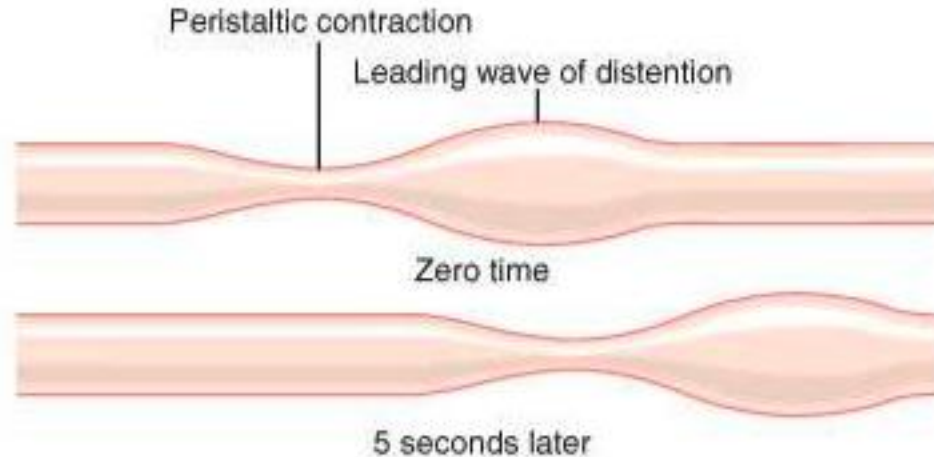
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Imagine pinching a tube and sliding your fingers along the tube.

- Reflex response that is initiated when the gut wall is stretched by the contents of the lumen and it occurs in all parts of the GI tract from esophagus to rectum.
- Oral-caudal direction->food move forward

Muscle Contraction for Peristalsis

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The smooth muscle of the gut is a syncytium.

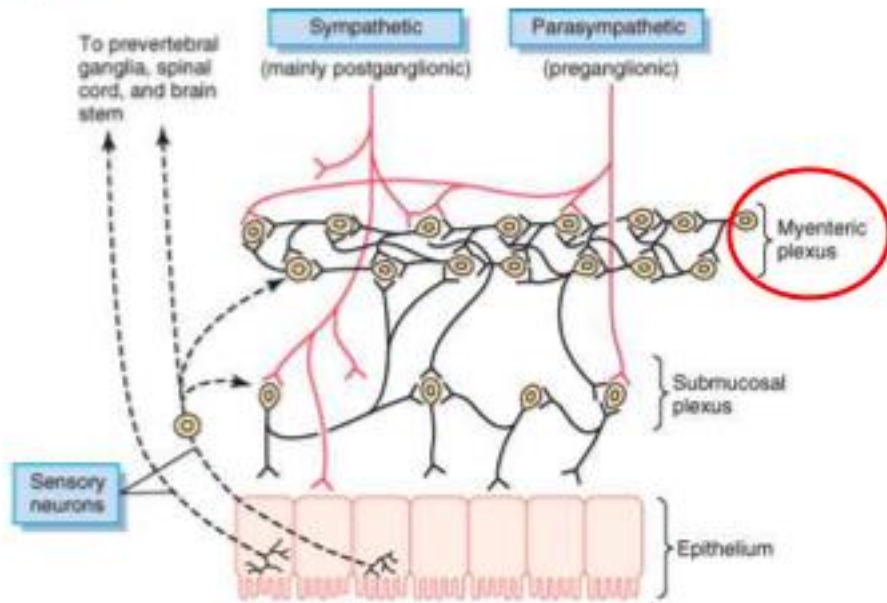
Thus, stimulation at 1 point spreads to adjacent areas, creating a peristaltic spread. Peristalsis also occurs in the bile ducts, glandular ducts, and ureters.

Stimulation of Peristalsis

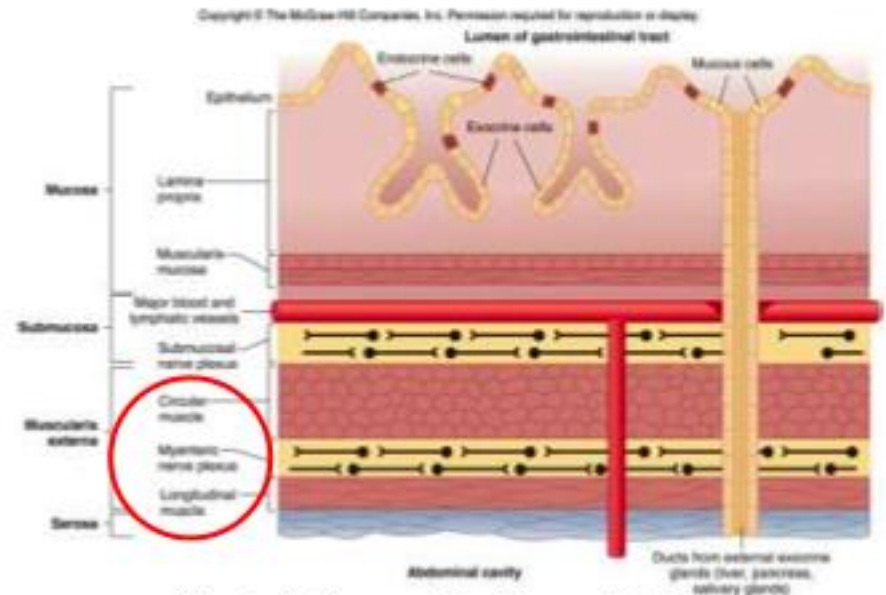
- Stretching of the gut wall, such as occurs with a large amount of food, stimulates contraction 2-3 cm behind the stretched wall.
- This initiates the peristalsis that propels the food forward.
- Other stimuli include parasympathetic signals and physical or chemical irritation of the epithelial lining.

Neurons Controlling Peristalsis

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Vander's Human Physiology, 11th Ed.

The myenteric plexus primarily controls peristalsis. It is an interconnected chain of neurons between the longitudinal and circular layers of muscle that extends the entire length of the GI tract.

The submucosal plexus mainly controls GI secretion and local blood flow.

Myenteric Plexus

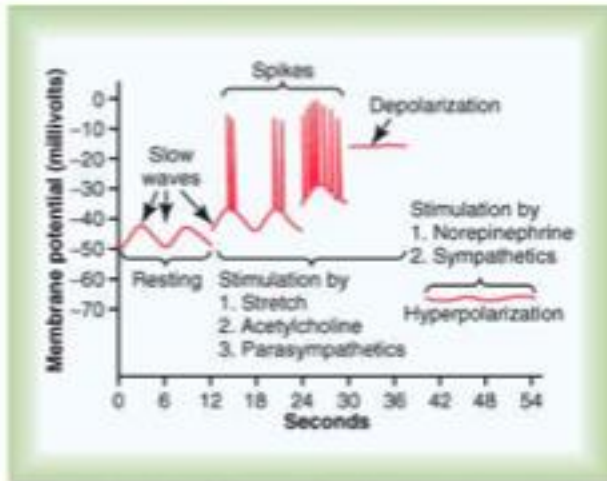
- Stimulation of the myenteric plexus causes:
 - Increased tonic contractions
 - Increased intensity of contractions
 - Slight increase in rhythm of contractions
 - Increased velocity of excitatory waves along the gut wall
- Blocking the myenteric plexus or its parasympathetic stimulation greatly decreases peristalsis.

Directional Movement in GI Tract

- The forward movement of food is achieved by:
 - The initiation or peristalsis 2-3 cm behind the distended wall.
 - Relaxation of the gut wall in front of the distended wall.
- This pattern requires the myenteric plexus and is called the *myenteric peristaltic reflex*.

Electrical Activity in GI Smooth Muscle

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- Excited by fairly constant, slow electrical activity that consists of 2 types of electrical activity:

1. Slow waves
2. Spikes

Note: the resting membrane potential can be adjusted. This is important, as spikes occur once a threshold resting membrane potential is reached.

SEGMENTATION AND MIXING

- When the meal is present, the enteric NS promotes a motility pattern that is related to peristalsis but designed to retard movement of the intestinal contents along the length of the intestinal tract to provide time for digestion. This is called segmentation
- Provide mixing of chyme with digestive juices
- Mixing pattern persists for as long as the food is there in the lumen

- A segment of bowel contracts at both ends and then a second contraction occurs in centre of the segment to force the chyme both backward and forward

GASTRIC MOTILITY AND EMPTYING

- Food enters stomach->fundus and upper portion of body relax->accommodate food->peristalsis->mixing->grinding
- Semiliquid portions pass to pylorus and enter the duodenum
- Mediated by triggered movement of pharynx and esophagus

Stomach Emptying

- Most of the stomach contractions mix the food with gastric juices.
- Strong contractions occur ~ 20% of the time. These propel larger amounts of chyme through the pylorus (pyloric pump).
- The pylorus is tonically contracted to a point where fluid easily passes, but unprocessed food does not.

Regulation of Stomach Emptying by the Stomach

- Stomach emptying is regulated somewhat by the stomach itself. Stretching stimulates myenteric reflexes that enhance the pyloric pump, relaxes the pylorus and stimulates the release of the hormone, **gastrin**.
- Gastrin causes the secretion of acidic gastric juices and moderately stimulates the pyloric pump.
- The digestive products of meat also stimulate gastrin release.

Regulation of Stomach Emptying by the Duodenum

- A more important regulator of stomach emptying is the duodenum.
- Control by the duodenum prevents the movement of excess food into intestines. Too much food would limit the ability to reabsorb nutrients.
- The inhibition of stomach emptying by the duodenum is mediated by nervous reflexes and hormones.

Inhibition of Stomach Emptying by the Duodenum Nerve Reflexes

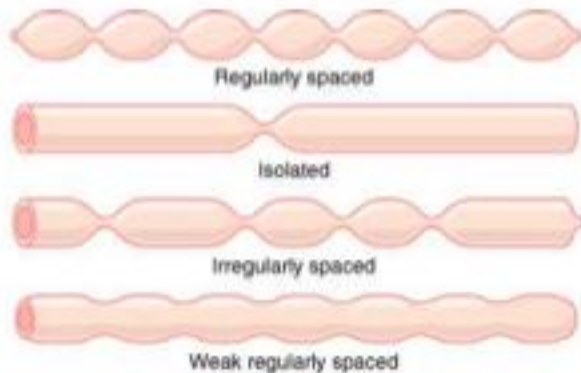
- Factors that inhibit stomach emptying by the duodenum are:
 - Distension of the duodenum
 - High acidity of the chyme
 - Hypertonic and hypotonic chyme (particularly hypertonic)
 - Breakdown products of proteins and to a lesser extent, fat
 - Irritation of the duodenum

Inhibition of Stomach emptying by the Duodenum Hormones

- Fats in the duodenum inhibit stomach emptying by extracting hormones from the epithelium.
- One important hormone is cholecystokinin (CCK). Other hormones will be discussed later.
- CCK inhibits stomach motility induced by gastrin.

Movement in the Small Intestine

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- Stretching of the intestine causes peristaltic contractions that cause forward movement and mixing.
- Movement is slow to allow greater absorption of nutrients (1 cm/min). At this rate, it takes 3-5 hr for food to pass through the small intestine.
- Hormones that increase peristaltic activity are gastrin, CCK, insulin, motilin, and serotonin.
- Hormones that inhibit intestinal motility are secretin and glucagon.

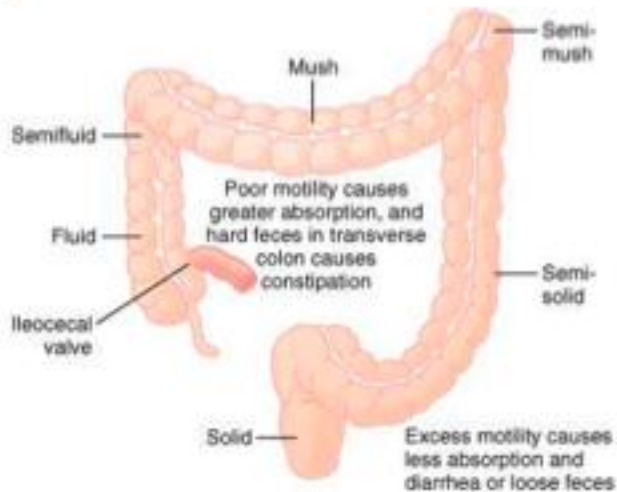
- 3 types of smooth muscle contractions
- Peristalsis-propels intestinal contents to the large intestines
- Segmentation contractions-moves the chyme to and fro to increase its exposure to the mucosal surface
- Tonic contractions-prolonged contractions that isolate one segment of intestine from another.

Peristaltic Rush

- Normally, peristalsis in the small intestine is weak. As indicated by the slow movement of food.
- However, irritation, as occurs with infectious diarrhea, causes rapid and powerful peristalsis.
- This involves the autonomic nervous system and intrinsic control of the myenteric plexus.

Movements in the Colon

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- The colon absorbs water and nutrients, progressively making solid feces.
- It also stores the solid feces until it can be expelled.
- Movement is slow, requiring 8-15 hr to move material through the colon.
- Movement and mixing are achieved by peristaltic-like contractions.

- MOTILITY OF COLON-Segmentations ,peristaltic waves and mass action contraction
- Segmentation-mix contents and facilitate absorption
- Peristaltic wave-propel contents to rectum
- mass action contraction-occur 10 times per day ,simultaneous contraction –move material from one portion of colon to another and also to rectum.
- Rectal retention initiates the process of defecation

Propulsive (Mass) Movements

- Occasionally (1-3 times/day), a modified contraction will propel the contents forward *en masse*.
- This occurs by a peristaltic contraction pushing the contents through 20 cm or more of colon in which the haustrations are relaxed.
- A series of mass movements persist for 10-30 min; then cease. They may recur ~ 12 hr later.
- Irritation can cause mass movements.

DEFECATION

- **Defecation** is the final act of digestion, by which organisms eliminate solid, semisolid, and/or liquid waste material from the digestive tract via the anus.
- Rectal distention-relaxes the sphincter-rectal pressure increases to 18mmHg-55 mm Hg
- Both external and internal sphincter relaxes-reflex expulsion of contents of the rectum