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NAAC ACCREDITED 'A' GRADE

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Mechanical digestion of food

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Mechanical digestion

- A purely physical process (eg. chew, tear, grind, mash, and mix) that does not change the chemical nature of the food but breaks down food into smaller to increase both surface area and mobility
- Occurs in the following locations:
  - Mouth: teeth, tongue and palates (chewing)
  - Esophagus: (peristalsis)
  - Stomach: (muscular churning action, peristalsis)
  - Small intestine: (segmentation, peristalsis)
  - Large intestine: (haustral churning, mass peristalsis)

Mechanical digestion in Mouth

- Chewing, or **mastication**, in which food is manipulated by the tongue, ground by the teeth, and mixed with saliva.
- As a result, the food is reduced to a soft , flexible, easily swallowed mass called a **bolus** (= lump).
- Teeth mechanically break down food into small pieces.
- Tongue mixes food with saliva

Process of chewing:

- bolus of food in the mouth →
- reflex inhibition of the muscles of mastication →
- allows the lower jaw to drop →
- stretch reflex of the jaw muscles →
- to *rebound* contraction →
- raises the jaw to cause closure of the teeth, and compresses the bolus again against the linings of the mouth →
- inhibits the jaw muscles once again →
- allowing the jaw to drop and rebound another time →
- repeated again and again

Importance of chewing

- Important for digestion of all foods
- as it breaks food into smaller pieces that are easier to swallow
- especially important for 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
- It makes digestion by enzymes easier as there is a larger surface area for enzymes to act when the food has been broken up.
- Allows the food to be mixed with saliva that contains mucus to help food to move easily along the alimentary canal.
- grinding the food to a very fine particulate consistency prevents excoriation of the gastrointestinal tract and increases the ease with which food is emptied from the stomach into all succeeding segments of the gut

Swallowing/ deglutition

- The movement of food from the mouth into the stomach is achieved by the act of **deglutition** or *swallowing*.
- facilitated by the secretion of saliva and mucus and involves the mouth, pharynx, and esophagus
- Swallowing occurs in three stages:
  - (1) the voluntary stage, in which the bolus is passed into the oropharynx;
  - (2) the pharyngeal stage, the involuntary passage of the bolus through the pharynx into the esophagus; and
  - (3) the esophageal stage, the involuntary passage of the bolus through the esophagus into the stomach.

Mechanical digestion in Esophagus

- **Peristalsis -** a progression of coordinated contractions and relaxations of the circular and longitudinal layers of the muscularis, that pushes the bolus onward
- Normally exhibits two types of peristaltic movements: *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
- If the primary peristaltic wave fails to move into the stomach all the food that has entered the esophagus, *secondary peristaltic waves* result from distention of the esophagus itself by the retained food; these waves continue until all the food has emptied into the stomach
- Mucus secreted by esophageal glands lubricates the bolus and reduces friction.

Mechanism of peristalsis

1 . In the section of the esophagus just superior to the bolus, the circular muscle fibres contract, constricting the esophageal wall and squeezing the bolus toward the stomach.

2. Longitudinal fibres inferior to the bolus also contract, which shortens this inferior section and pushes its walls outward so it can receive the bolus. The contractions are repeated in waves that push the food toward the stomach.

3. Steps **1** and **2** repeat until the bolus reaches the lower esophageal sphincter muscles.

4. The lower esophageal sphincter relaxes and the bolus moves into the stomach.

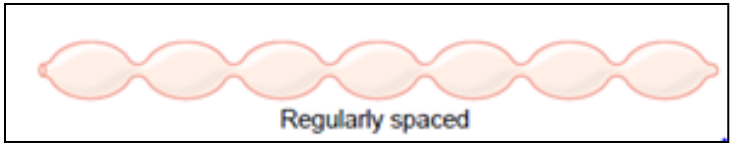
Mechanical digestion in the Stomach

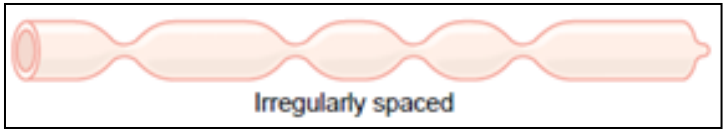
- Several minutes after food enters the stomach, waves of peristalsis (*mixing waves*) pass over the stomach every 15 to 25 seconds.
- Each peristaltic wave moves gastric contents from the body of the stomach down into the antrum (**propulsion)**.
- The pyloric sphincter normally remains almost closed (not completely). Because most food particles in the stomach initially are too large to fit through the narrow pyloric sphincter, they are forced back into the body of the stomach (**retropulsion)**.
- Another round of propulsion then occurs, moving the food particles back down into the antrum
- Ultimately gastric contents are mixed with gastric juice, and become reduced to a soupy liquid called **chyme**.
- Once the food particles in chyme are small enough, they can pass through the pyloric sphincter (**gastric emptying)**.

Mechanical digestion in Small Intestine

- The two types of movements of the small intestine—segmentations and a type of peristalsis called migrating motility complexes—are governed mainly by the myenteric plexus.
- **Segmentations** are localized, mixing contractions that occur in portions of intestine distended by a large volume of chyme.
- Segmentations mix chyme with the digestive juices and bring the particles of food into contact with the mucosa for absorption; they do not push the intestinal contents along the tract.
- Segmentations occur most rapidly in the duodenum, about 12 times per minute, and progressively slow to about 8 times per minute in the ileum.

- When a portion of the small intestine is distended with chyme, stretching of the wall elicits localized concentric contractions of circular muscle fibres spaced at intervals along the intestine. The contractions cause “segmentation” of the small intestine (divide the intestine into spaced segments having the appearance of a chain of sausages).
- As one set of segmentation contraction relaxes, a net set begins at new points.
- Therefore, the segmentation contractions “chop” the chyme two to three times per minute, in this way promoting progressive mixing of the food with secretions of the small intestine.





- After most of a meal has been absorbed, distension of the wall of small intestine lessens, segmentation stops and peristalsis begins

- The type of peristalsis that occurs in the small intestine, termed a **migrating motility complex (MMC)**, begins in the lower portion of the stomach and pushes chyme forward along a short stretch of small intestine before dying out.
- The MMC slowly migrates down the small intestine, reaching the end of the ileum in 90–120 minutes.
- They normally are very weak and usually die out after traveling only 3 to 5 cm, so that forward movement of the chyme is very slow (*net* movement along the small intestine normally averages only 1 cm/min). So 3 to 5 hours are required for passage of chyme from the pylorus to the ileocecal valve.
- It sweeps the intestine clean of remnants of food and digested products.
- MMCs stop as soon as food enters stomach and intestine.

Functions of peristalsis

- Augments the digestion of chyme by mixing it with digestive juices of other parts of intestine.
- Cause progression of chyme towards ileocecal valve
- Spread out chyme along the intestinal mucosa
- Augments absorption of chyme
- Pushes the bacteria, which might have come from the colon into the small intestine, back into the colon.
- Helps to expel intestinal gases.

Mechanical digestion in Large Intestine

- Movements of the colon begin with passage of chyme from the terminal ileum through the ileocaecal sphincter into the caecum. This is known as gastroileal reflex that intensifies peristalsis in the ileum .
- A characteristic movement of the large intestine is **haustral churning** where the haustra remain relaxed and become distended while they fill up.
- Peristalsis also occurs, at a slower rate (3–12 contractions per minute).
- A final type of movement is **mass peristalsis**, a strong peristaltic wave that begins at about the middle of the transverse colon and quickly drives the contents of the colon into the rectum.

Haustral churning:

- Large circular constrictions occur in the large intestine.
- At each of these constrictions, about 2.5 cm of the circular muscle contracts.
- At the same time, the longitudinal muscle of the colon, which is aggregated into three longitudinal strips called the *teniae coli*, contracts.
- These combined contractions of the circular and longitudinal strips of muscle cause the unstimulated portion of the large intestine to bulge outward into baglike sacs called *haustrations*.
- When the distension reaches a certain point, the walls contract and squeeze the contents into the next haustrum.

Mass peristalsis

- A mass movement is a modified type of peristalsis in which there is simultaneous contraction over a large portion of colon starting from the caecum.
- First, a constrictive ring occurs in response to a distended or irritated point usually in the transverse colon.
- Then, rapidly the 20 or more cm of colon distal to the constrictive ring lose their haustrations and instead contract as a unit, propelling the faecal material in this segment further down the colon.
- The contraction develops progressively more force for about 30 seconds, and relaxation occurs during the next 2 to 3 minutes.
- Then, another mass movement occurs, farther along the colon.
- As a result, colonic contents reach the rectum and initiate the defecation reflex.