Human physiology

Digestion physiology

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Digestion is the process of mechanically and enzymatically breaking down food into substances for absorption into the bloodstream. The food contains three macronutrients that require digestion before they can be absorbed: fats, carbohydrates, and proteins.

Digestion is a form of catabolism or breaking down of substances that involves two separate processes:

- mechanical digestion: Mechanical digestion involves physically breaking down food substances into smaller particles to more efficiently undergo chemical digestion.

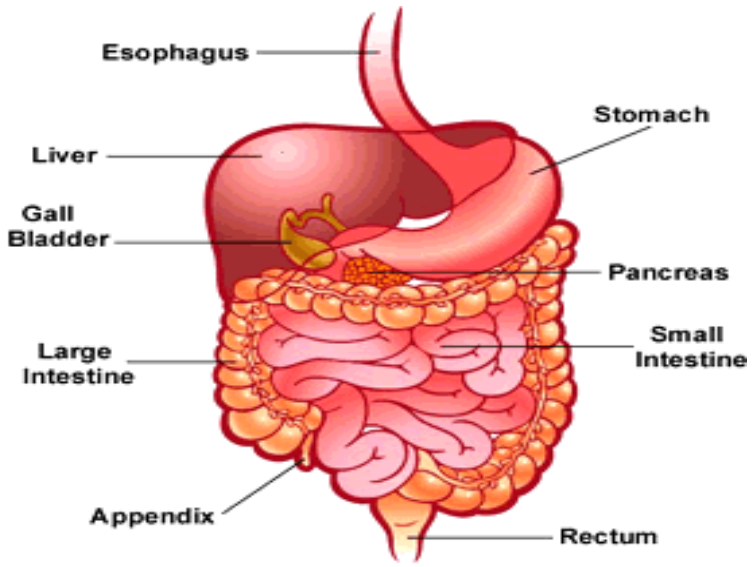
-chemical digestion: the role of chemical digestion is to further degrade the molecular structure of the ingested compounds by digestive enzymes into a form that is absorbable into basic unit.

The digestive system involves —hollow‖ organs and —solid‖ organs.

Food travels through the hollow organs — mouth, esophagus, stomach, small intestine, large intestine, and anus.

The solid organs :—

pancreas, liver, and gallbladder — add various products into the mix. Aside from the **solid** and **hollow** organs, the nervous and circulatory systems are also important in digestion, as are the bacteria that live in the gut.



Functions of digestive system:

1. **Ingestion**: This process involves taking foods and liquids into the mouth (eating).

2. Secretion: Cells within the walls of the GI tract and accessory digestive organs secrete about 7 liters of water, acid, buffers, and enzymes into the tract which help in digestion of food.

3. Mixing and propulsion: Alternating contractions and relaxations of smooth muscle in the walls of the GI tract mix food and secretions and propel them toward the anus. This capability of the GI tract to mix and move material along its length is called motility.

4. Digestion: Digestion is of two types- Mechanical and Chemical digestion.

5. Absorption: The entrance of ingested and secreted fluids, ions, and the products of digestion into the epithelial cells lining the lumen of the GI tract is called

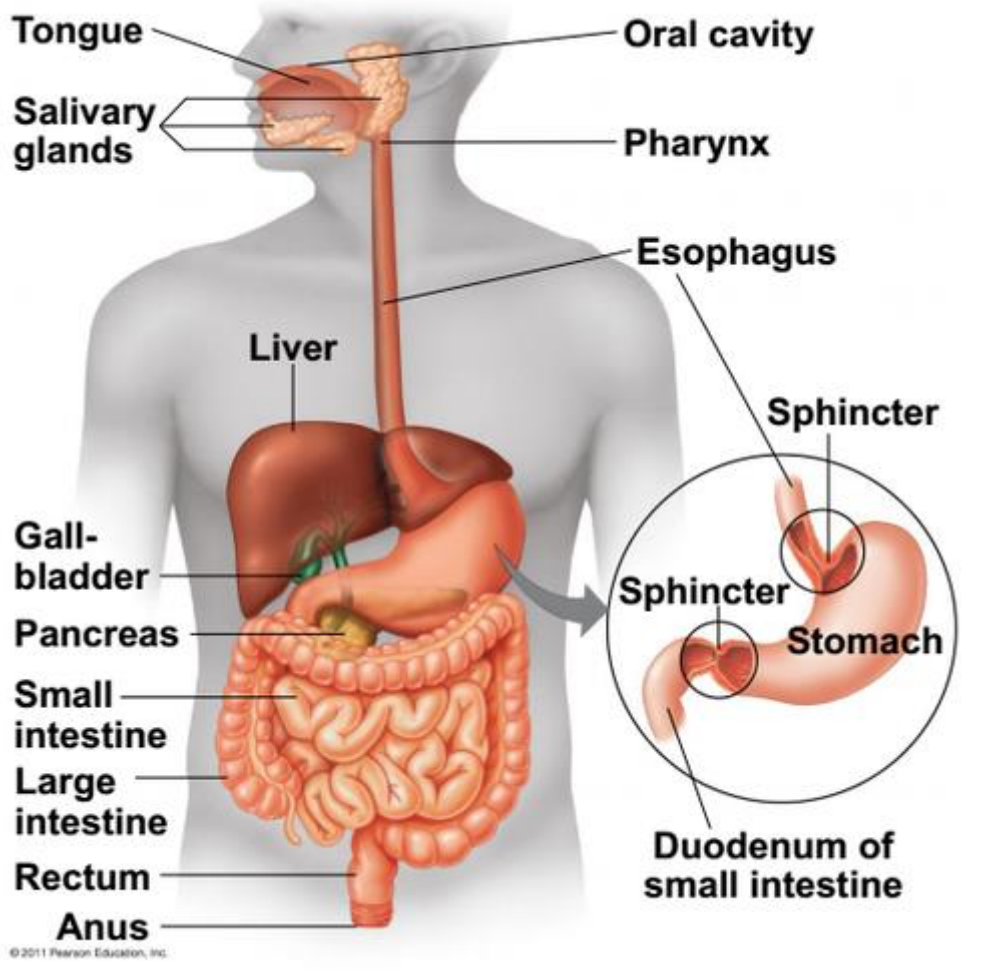
absorption. The absorbed substances pass into blood or lymph and circulate to cells throughout the body.

6. Defecation: Wastes, indigestible substances, bacteria, cells sloughed from the lining of the GI tract, and digested materials that were not absorbed in their journey through the digestive tract leave the body through the anus in a process called defecation. The eliminated material is termed feces

Parts of digestive system:

The journey of digestion In humans, the gastrointestinal tract (also called the alimentary canal) is around 8 meters long. One writer describes it as —the most important and least lovely waterway on Earth.

Below, we describe the journey of a mouthful of food



1- The Mouth

Digestion begins even before the food enters the mouth. The smell, or even the thought of food, starts the production of **saliva** by the salivary glands. Once the food is inside the mouth, it is moistened by saliva, and the teeth and tongue begin the process of mechanical digestion.

2- **Salivary glands**: A salivary gland is a gland that releases a secretion called saliva into the oral cavity. Saliva is secreted to keep the mucous membranes of the mouth and pharynx moist and to cleanse the mouth and teeth. When food enters the mouth, secretion of saliva

increases, and it lubricates, dissolves and begins the chemical breakdown of the food. There are 3 pairs of major salivary glands which secrete saliva:

a- **The parotid glands**:

b- The submandibular glands

c- The sublingual glands

3-Peristalsis

Peristalsis is the slow contraction of smooth muscles around the pipes of the digestive system. Slow waves of contraction run along the gut, pushing the bolus along in the right direction — away from the mouth and toward the anus.

4- The stomach

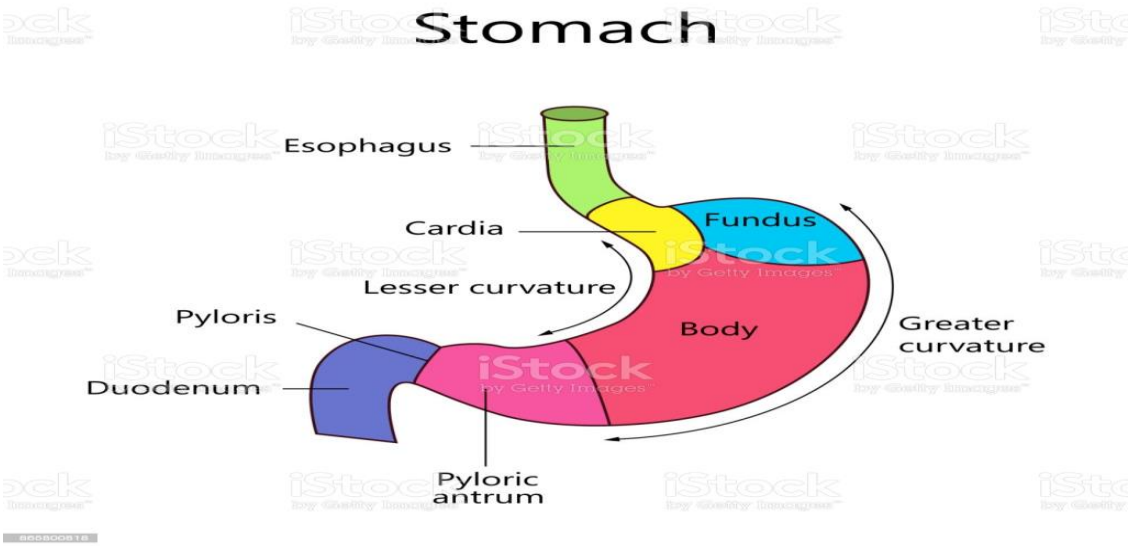
The bolus enters the stomach through a muscular valve at the top called the **cardiac sphincter**. This sphincter controls how much food enters the stomach and when.

Stomach is a 'J' shaped enlargement of GI Tract which lies directly inferior to diaphragm. It connect **esophagus to duodenum** (first part of small intestine). Stomach serves as mixing chamber and holding reservoir for food. When food is ingested, stomach pushes a small quantity of food into duodenum periodically. As the size of stomach can vary, it can store large amount of food. In stomach, semisolid bolus is converted into liquid, digestion of starch continues, digestion of triglycerides and protein starts and absorption of several substances takes place.

The stomach contains gastric juice, which contains mostly:

- **Hydrochloric acid** — an acid that is strong enough to dissolve razor blades.
- **Pepsin — an enzyme** that breaks down proteins.

Both of these chemicals could potentially harm the lining of the stomach, so it produces a slimy layer to protect itself from damage. In the stomach, peristalsis continues, which helps to mix the food with the gastric juices. Not many compounds are absorbed into the blood from the stomach; exceptions to this include water, alcohol, and non-steroidal anti inflammatory drugs .



After 1–2 hours in the stomach, the food is a thick paste, referred to as **chyme**. It leaves the stomach through the **pyloric sphincter** at the bottom of the stomach.

As digestion proceeds more vigorous mixing wave start at body of stomach and intensify as they reach pylorus. At pylorus, each wave periodically pushes little amount of **chyme** into **small intestine** thorough **pyloric sphincter**. This process is called **gastric emptying.**

Starch is digested by salivary amylase when food is in **fundus**. When food moves into body, mixing of chyme with gastric juices starts. The salivary amylase is inactivated and lingual lipase is activated. This stops digestion of starch and starts digestion of triglycerides into diglycerides and fatty acids.

- Parietal cell present in walls of stomach start secretion of a strong acid HCl, which kills microbes and denature proteins. HCl also stimulate secretion of hormones which further increases flow of bile and pancreatic juices.

- **Enzymatic digestion** of proteins also begins in the stomach. The chief cells in stomach secrete proteolytic (protein-digesting) enzyme in the stomach called pepsin. Pepsin breaks peptide bonds to breaking down a large protein chain smaller peptide fragments. Pepsin is most effective in the very acidic environment of the stomach (pH 2); it becomes inactive at a higher pH.

The small intestine

The duodenum is the first section of the small intestine. Here, the chyme mixes with enzymes from the pancreas, bile from the liver, and intestinal juice:

Bile \ produced by the liver, it helps break down fats and is stored in the gallbladder.

Pancreatic juice \ contains a cocktail of enzymes, including trypsinogen, elastase, and amylase.

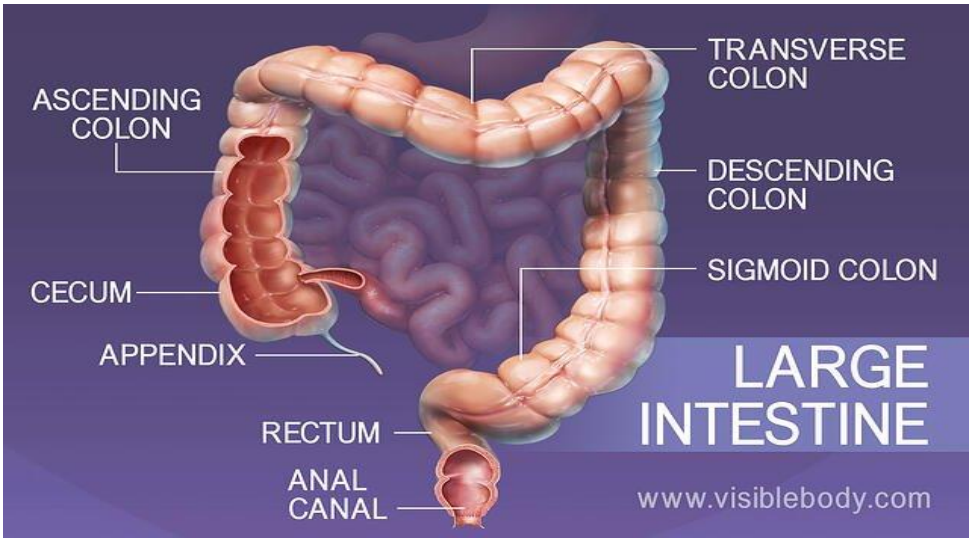
Intestinal juice \ this fluid activates some of the enzymes in the pancreatic juice. It also contains other enzymes, mucus, and hormones.

The food continues its journey through the remaining parts of the small intestine **the jejunum and ileum** — being gradually digested as it goes. Once it is fully broken down, it is absorbed into the blood.

In humans, the vast majority of nutrients are absorbed in the small intestine.

Tiny finger-like projections called villi stick out from the walls of the duodenum and increase its surface area. Villi maximize the amount of nutrients that can be absorbed. The surface area is further increased by microvilli, which are even smaller projections that come from the cells of the intestine's epithelium (lining).

The large intestine



Also called the colon and large bowel, the large intestine is 1.5 meters (5 feet) in length. Although it is shorter than the small intestine, it is thicker in diameter.

In the large intestine, water and minerals are absorbed into the blood. Food travels through this region much slower to allow fermentation by gut bacteria.

The large intestine absorbs any products produced by bacterial activity, such as vitamin K, vitamin B12, thiamine, and riboflavin.

The large intestine is divided into sections:

The ascending colon :- this includes the cecum (a pouch that joins onto the ileum) and the appendix (another small pouch. Its function is unclear, but it may play a role in maintaining gut bacteria).

The transverse colon :- this section Crosse the abdomen. The descending colon – this section has a dense population of gut bacteria and is used to store feces.

The sigmoid (S-shaped) colon :- has muscular walls that help push feces

The rectum

Any waste left over that the body cannot use is moved to the rectum and excreted through the anus during defecation. This may occur multiple times in a single day, or once every few days.

Stretch receptors in the wall of the rectum detect when the chamber is full and stimulate the desire to defecate. If defecation is delayed, the feces can be moved back into the colon where water is absorbed back into the body. If defecation is postponed for an extended period, more water is removed, the stool becomes hard, and the individual may become constipated.

How nutrients are broken down

Different components of the diet are broken down in various ways:

Protein :- digested by three enzymes called pepsin (in the stomach), trypsin, and chymotrypsin (in the duodenum, secreted by the pancreas).

Fat :- lingual lipase begins fat digestion in the mouth. However, most fat is broken down in the small intestine by pancreatic lipase. Bile also helps in the process of breaking down fats.

Carbohydrate :- salivary and pancreatic amylase break down starches into individual glucose units. Lactase breaks down lactose, the sugar in milk. Sucrose breaks down sucrose (table sugar or cane sugar).

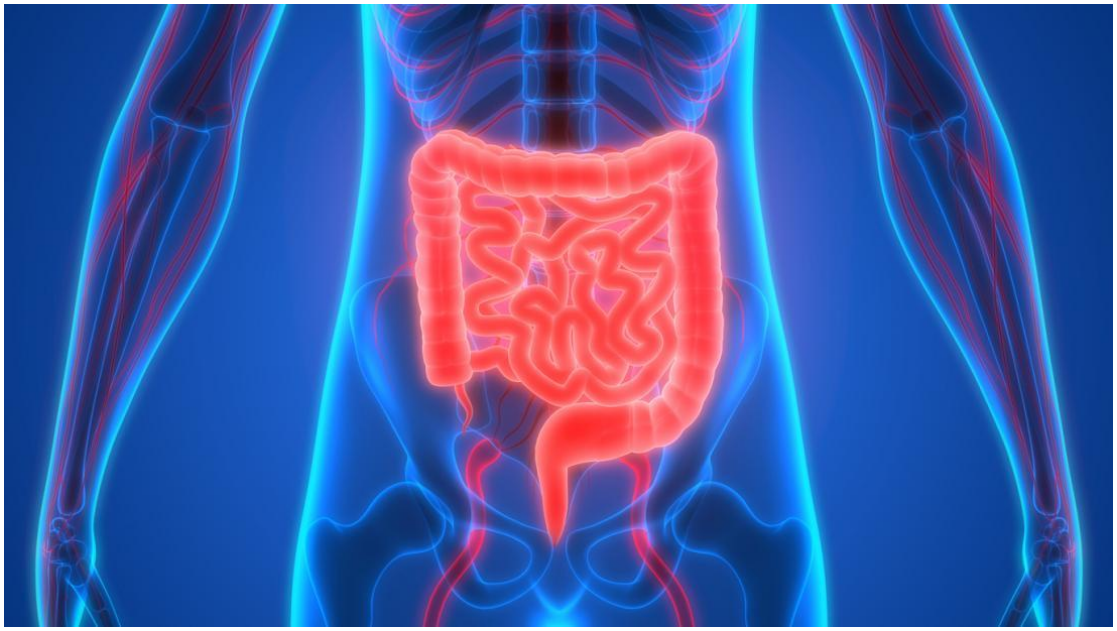
DNA and RNA :- broken down by deoxyribonuclease (DNase) and ribonuclease (RNase) produced by the pancreas.

Non-destructive digestion

Certain essential, complex molecules would be ruined if they mixed with digestive juices in the stomach. For instance, vitamin B12 is very sensitive to acid and, if it was broken down into its parts, it could not fulfill its role in the body.

In these cases, non-destructive digestion takes place. For vitamin B12, a chemical in saliva called haptocorrin binds to and protects the molecule.

In the duodenum, the bond is split, and B12 attaches to intrinsic factor. Then, once in the ileum, special receptors carry the two bound molecules into the blood.



Hormonal control of digestion

Digestion is a complex process that requires different organs to make moves at the right time. For instance, the right enzymes need to be squirted into the right place at the right time and in the right amounts. To help organize this system, a range of hormones are involved, these include:

1-Gastrin :- released in the stomach, this hormone stimulates the production of hydrochloric acid and pepsinogen (an inactive form of pepsin). Gastrin is produced in response to the arrival of food in the stomach. Acidic pH levels reduce the levels of gastrin. **2-Secretin** :- stimulates bicarbonate secretion to neutralize acid in the duodenum.

3-Cholecystokinin (CCK) :- also found in the duodenum, this hormone stimulates the pancreas to release enzymes and the gallbladder to release bile.

4-Gastric inhibitory peptide :- decreases the churning of the stomach and reduces the speed that food empties from the stomach. It also triggers the secretion of insulin.

5- Motilin :- stimulates the production of pepsin and speeds up peristalsis.

Digestive Problems

1. Choking food in air passages usually meats, hot dogs, grapes, carrots, hard candy, popcorn, peanut butter may not be able to make a sound DON'T hit on back

2. Vomiting symptom of many diseases waves of reverse peristalsis if severe may empty duodenum as well rest and drink small amounts of fluids guard against massive fluid loss

3. Bulemia self induced vomiting may cause damage and infection of esophagus, pharynx, or salivary glands erosion of teeth, more dental caries esophagus may rupture or tear

4. Diarrhea frequent loose watery stool intestinal contents moving too fast for fluid absorption to occur main danger is fluid loss also upsets acid/base balance

5. Constipation caused by: lifestyle inadequate water input lack of physical activity side effect of medication increase in fiber, prunes, laxatives attracts water softens stool Colonic Irrigation alternative medical practice potentially harmful unneccessary can rupture the intestine frequent use of laxatives and enemas: can lead to dependency upset body's fluid balance Anatomy & Physiology: Digestive System, Ziser, 2003 14 mineral oil can interfere with absorption of fat soluble vitamins

6. Belching results from swallowed air carbonated drinks and chewing gums can contribute occasionally can be a sign of a more serious disorder: gall bladder pain, colonic distress eat slowly, chew thoroughly relax while eating

7. Hiccups repeated spasms of diaphragm may be triggered by eating or drinking too fast

8. Gas normally we expel several 100 ml of gas/day most is odorless 1% are —volatile‖ gasses high carb foods known to produce excess gas

9. Heartburn cardiac sphincter doesn't close properly eat or drink too much clothing too tight cure: eat small meals drink liquids 1 hr before or 1 hr after meal don't lie down or bend over lose weight if overweight don't smoke use antacids but sparingly

10. Ulcers caused by: bacterial infection use of some anti-inflammatory drugs disorders that cause excessive gastric secretions diet therapy used to be main cure, now antibiotics