

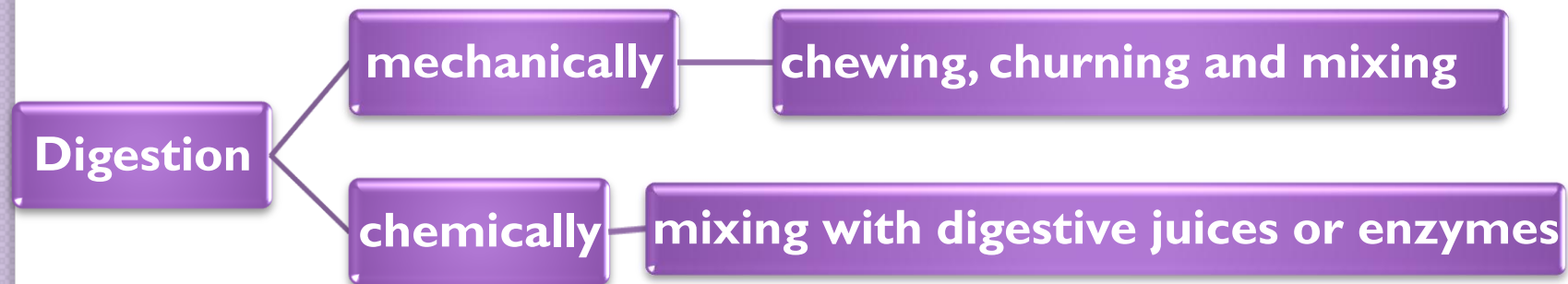


Digestion

إعداد

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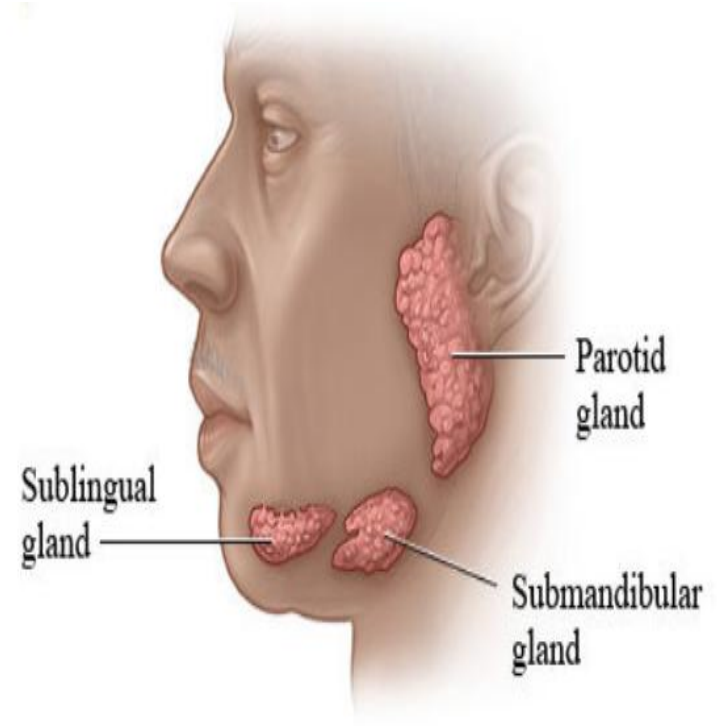
Digestion is the conversion of the ingested food materials into simpler and diffusible products to be utilized for metabolism used in → growth, repair, storage and energy production.



Digestion in mammals can be distinguished into **buccal, gastric, and intestinal** digestions.

Buccal Digestion

In the buccal cavity the food is mixed with the **saliva**, which is secreted by the **salivary glands**. In mammals four pairs of salivary glands are present; **the parotid, submandibular (submaxillary), sublingual, and infraorbital**. The latter pair is absent in humans.



Properties of saliva

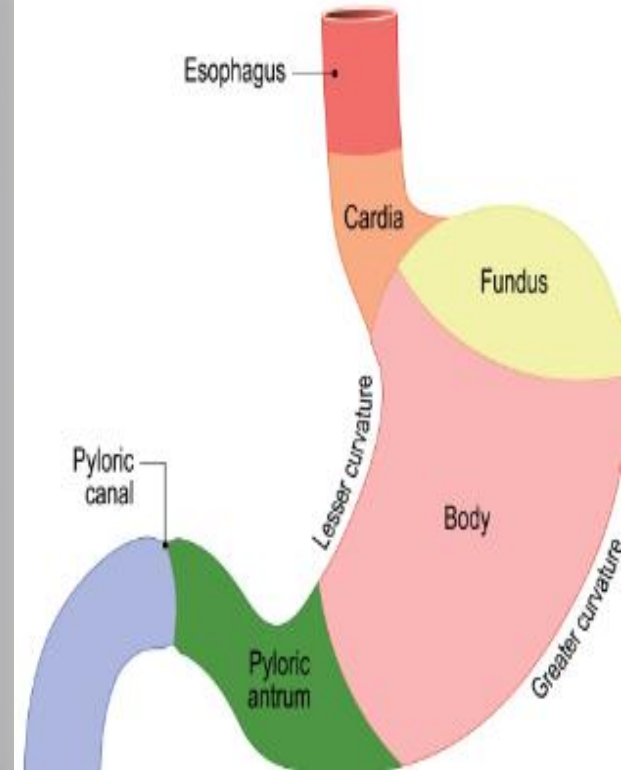
- It is a viscous, colorless and cloudy liquid.
- pH of 6.8 (5.6 -7.6).
- It contains:
 1. **Water (98.5- 99 %)**
 2. **Dense residues (1-1.5 %)** which includes:
 - Organic compounds such as enzymes and mucin.
 - Inorganic compounds such as salts of Cl^- , S^- , C_4^- , Na^+ , K^+ , Ca^{++} , Mg^{++} , NH_4^-
 - Cellular components such as epithelial cells, leukocytes, bacteria, and yeast.

Functions of saliva

- 1- Saliva moistens dry food.
- 2- Saliva dissolves sugars, salts, and other soluble substances.
- 3- Saliva converts starch into maltose by the action of amylase.
- 4- Saliva cools down the hot food.
- 5- Saliva cleans the mouth and throat.
- 6- Saliva facilitates the movements of tongue and lips.
- 7- Saliva contains buffering systems (bicarbonate, phosphate and mucin).
- 8- Saliva helps in the water balance of the body.

Gastric digestion

- In the stomach a mechano-chemical process takes place.
- The gastric juice secreted by three types of gastric glands:
 - 1- **Cardiac glands** secrete **mucous**.
 - 2- **Fundic glands** composed of two types of cells **the central or chief cells** which secrete **pepsin and rennin**, and **parietal cells** which secrete **HCl**.
 - 3- **Pyloric glands** secrete **pepsin and rennin**.



Intestinal digestion

Three different juices are concerned in the intestinal digestion; **the pancreatic juice, the bile, and the intestinal juice.**

(a) Pancreatic juice:

- The fresh pancreatic juice is **alkaline.**
- Pancreatic secretion is a **complete digestive juice** because it contains protein splitting enzymes (**trypsin and peptidases**), carbohydrate splitting enzymes (**pancreatic amylase and invertases**), fat splitting enzyme (**lipase**) and nucleic acids splitting enzymes.

(b) Bile juice: The bile is secreted from **the liver** and stored in the **gall bladder** in a concentrated form.

The important constituent of the bile are **bile acids and their salts, bile pigments, lipids, proteins, inorganic salts, and water.**

Functions of the bile:

- 1- stimulates the peristaltic movement of the intestine.
- 2- helps in absorption of proteins and carbohydrates.
- 3- helps in emulsification of fats and its absorption
- 4- helps in absorption of fat-soluble vitamins.
- 5- stimulates pancreatic secretion.
- 6- activates pancreatic lipase in the gut lumen.
- 7 - inhibits reabsorption of water and electrolytes in the colon, and increase colon motility.
- 8- bile acids increase the bile flow.
- 9- bile pigments impart a color to the feces.
- 10- the inorganic salts in the bile act for balancing osmotic-pressure of extracellular fluids.

(c) Intestinal juice: The intestinal glands are present in crypts of Lieberkuhn, which secrete the intestinal juice.

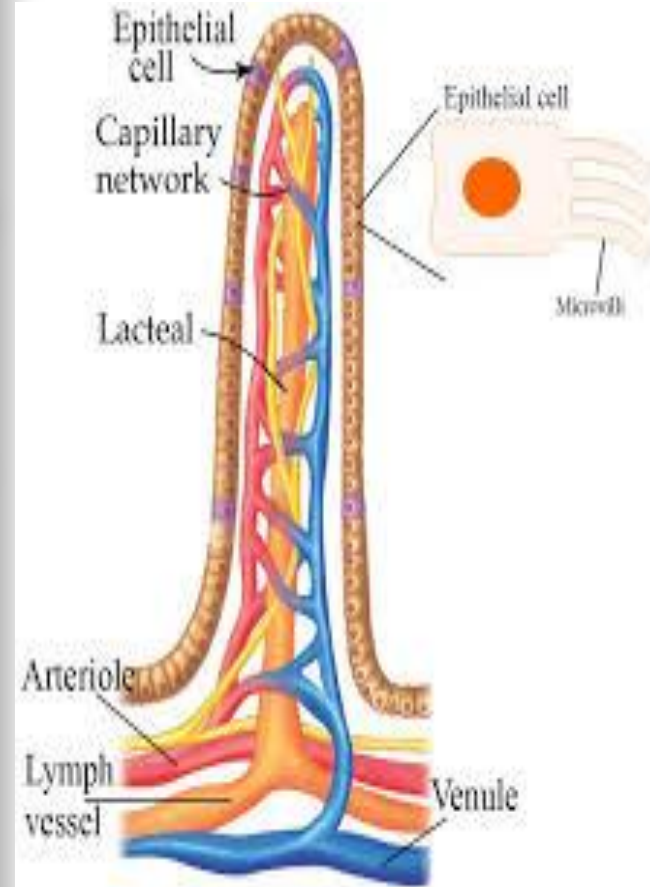
Important enzymes of the intestinal juice are:

- **Enterokinase:** is secreted in the intestine to activate trypsinogen of the pancreas into active trypsin.
- **Peptidases:** enzymes hydrolyse proteoses, peptones, and peptides into amino acids. They may be carboxypeptidases or aminopeptidases.
- **Invertases:** include maltase, lactase, sucrase, and other inverting enzymes, which act upon maltose, lactose, sucrose and other disaccharides, respectively, converting them into monosaccharides or simple sugars.

ABSORPTION

The end product of digestion are absorbed into the **blood vessels and lymphatics**. The **small intestine** is main site for absorption.

The absorptive surfaces in the small intestine are known as the **villi**. Each villous is externally covered with the lining epithelium within which there is a network of blood capillaries and branches of lymphatic system (lacteals).



- **Monosaccharides, amino acids sodium chloride and water** are directly absorbed by the **blood vessels** of the villi from where they are carried into the circulation by means of **portal vein**.
- **Fats** are absorbed in the form of **glycerol and fatty acids**, which are taken up by **lacteals**. These lacteals open into lymph vessels, which then open into the **subclavian vein** by means of the **thoracic duct**.
- The excess amount of water is absorbed in the large intestine and faeces becomes hard or semi-solid.

METABOLISM

Metabolism is the biochemical and physiological changes that occur to the absorbed food in the tissues of the living organism. It can be divided into:

1-Catabolic process: in which energy is released with the breakdown of complex substances into simple ones.

2- Anabolic process: in which the energy is utilized, resulting in the formation of complex substances from simple ones.

Metabolism of Carbohydrates

Carbohydrates are absorbed in the form of **monosaccharides**.

- **Excess glucose** is carried to the liver and stored in the form of **glycogen (glycogenesis)**.
- When blood glucose level decreases, glycogen is broken down into glucose by **glycogenolysis**.
- Glucose is broken down into different products in the presence of oxygen as well as in the absence of it to produce energy (**glycolysis**).

Aerobically (glucose produced 36 ATP).

Anaerobically (glucose produced 2 ATP).

Metabolism of Proteins

- Proteins are absorbed in the form of **amino acids**.
- They are used in **building new tissues and replacing the worn out ones**.
- The excess amino acids are **deaminated** because the body can not store them. **The amino group** is converted to **ammonia** and **the rest of the molecule** can then **enter the citric acid cycle (for energy)** or **can be converted to glycogen or fat and stored**.
- Ammonia is a **toxic substance** so it is converted into **urea in the liver**, transformed by blood and excreted by the kidney in the urine.

- The nucleoproteins are **conjugated proteins** composed of **proteins and nucleic acids**.
- **The proteins** are hydrolyzed into amino acids in the intestine by the proteolytic enzymes and then metabolized into **urea** as other proteins.
- **The nucleic acids** are converted into nucleotides in the intestine then metabolized into nucleosides , then into **pentose sugar and purine base** (in the presence of phosphoric acid). **The purine** is then converted into **uric acid** and excreted in urine.

Metabolism of Fats

- Fats are hydrolyzed into fatty acids and glycerol by the effect of lipase enzyme.
- Fats are then transformed by lymph vessels to blood circulation from where they are transformed to different parts of the body.
- Fats can be stored in the adipose tissues under the skin or around the kidneys for future use as a source of energy or undergo various conversions to other lipid materials.

The liver

The liver is the largest gland in the body, which is associated to the alimentary canal. It consists of polygonal cells which are grouped in radiating columns inside lobules. The lobules are enclosed in prolongation of areolar connective tissue. The portal vein, hepatic artery, and the bile duct are enclosed in this tissue.



Functions of the liver

- 1- Production of the bile.
- 2 - Destruction of erythrocytes.
- 3- Accumulation of iron.
- 4- Heparin and prothrombin formation.
- 5- Production of fibrinogen.
- 6- Reservoir of blood.
- 7- Storage of vitamin A.
- 8- Liver in relation to metabolism.
- 9- Production of uric acid.
- 10- Detoxification organ.
- 11- Production of heat.



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