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Topic : Digestion and absorption

Digestion and absorption

- Digestion is defined as the conversion of nondiffusible food elements into diffusible constituents.
- Digestion is the conversion of large molecules into small ones.
- Digestion is the process by which food substances are broken down by mechanical and chemical means.
- Mechanical digestion comprises mastication or chewing, liquefaction of food by digestive juices, swallowing and peristalsis.
- Major utility of breaking up of food into small bits during chewing is to increase the surface area of food. It helps the enzymatic action.
- Chemical digestion includes the enzymatic action on food.
- All enzymes are chemically Proteins .
- All digestive enzymes are hydrolytic as they catalyse hydrolysis of nutrients.
- In hydrolysis of nutrients, a small amount of energy released as heat.

Digestive Enzymes

- Four main types of digestive enzymes are :
 1. Carbohydratase
 2. Proteinases
 3. Lipases
 4. Nucleases
- Carbohydratase include amylase (polysaccharides to disaccharides) and disaccharidases (Maltase, sucrase and lactase).
- Proteinases can be endopeptidase and exopeptidase .
- Lipase (steapsin) hydrolyses triglycerides to fatty acids and glycerol.
- Nuclease hydrolyse nucleic acid into nucleotides and finally into nitrogenous bases, pentose sugar and phosphate group.e.g., DNase and RNase.

Digestive juices in Alimentary canal

Digestive juice	Location
a) Saliva	Mouth
b) Gastric juice	Stomach
c) Bile	Duodenum
d) Pancreatic juice	Duodenum
e) Intestinal juice	Small intestine

Digestion in mouth cavity

- In mammals, the digestion starts from mouth. Masticated food in mouth is mixed with saliva secreted by salivary gland .

- Daily secretion of saliva in man is about 1-1.5litre.
- pH of saliva is about 6.8 (slightly acidic , almost neutral).
- Food mixed with saliva in the buccal cavity is called “bolus”.

Saliva contains a starch splitting enzyme ptyalin acts on starches by hydrolyzing 1:4 α linkages, changing them to the disaccharide maltose, the trisaccharide maltotriose and α - dextrins.

- Saliva also contains an anti-bacterial enzyme, lysozyme which dissolves the cell wall of Gram positive bacteria and kills them.
- The thiocyanate ions of saliva also act as antimicrobial agent.
- About 30 % of starch is hydrolysed in the mouth cavity.
- A lingual lipase is secreted by Ebner’s gland on the dorsal surface of tongue.
- Lingual lipase is active in the stomach only. It can digest as much as 30% of dietary triglycerides into fatty acids and 1,2-diacylglyceroles.
- There is no digestion in oesophagus. It conducts the food from mouth into stomach.

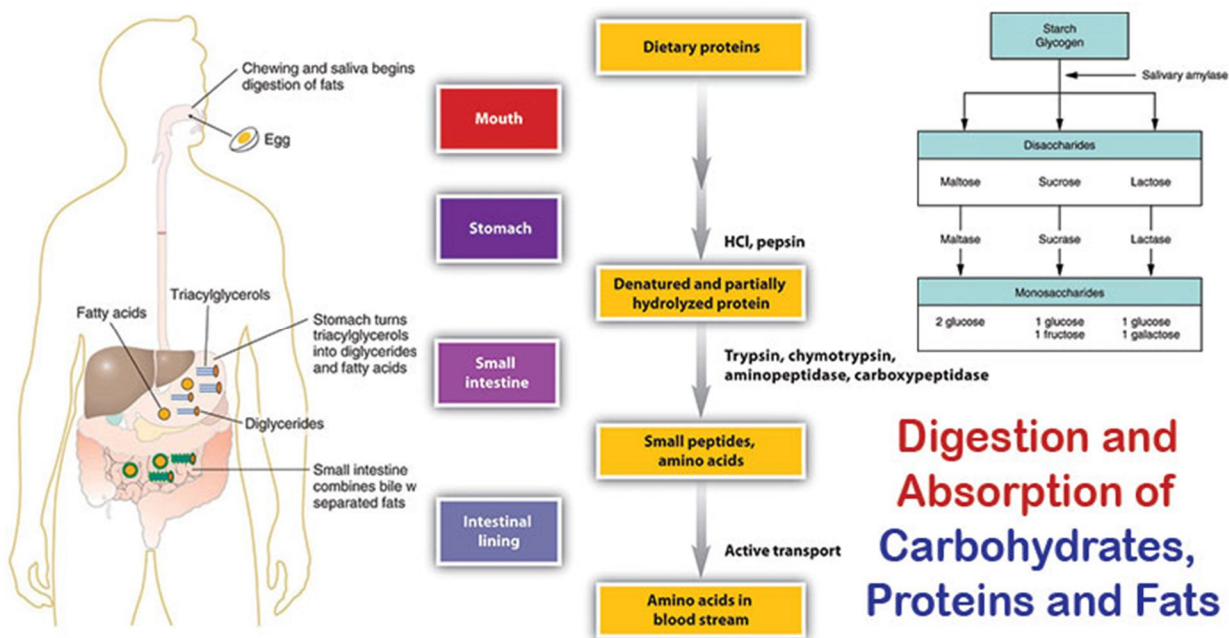


Fig: Digestion and Absorption of Carbohydrates, Proteins and Fats.

Digestion in stomach

- Stomach secretes gastric juice.
- Protein digestion starts in the stomach.
- Stomach is the chief site of protein digestion.
- Food mixed with gastric juice in the stomach is called 'chyme'.
- The columnar epithelium of stomach form many gastric pits with gastric glands.
- Gastric glands are located on mucosa of stomach.
- Gastric glands are lined with three kinds of secreting cells: zymogenic cell, parietal cells and mucous cells.

- The main, peptic or zymogen cells secrete digestive proenzymes namely pepsinogen and prorennin.
- Oxyntic cells secrete HCL.
- Pepsin acts on protein (pH 1 to 3.5) splitting into proteoses and peptones.
- The mucus secreted by stomach protects its wall from the action of pepsin.
- Rennin, also called chymosin, is found in calf gastric juice and it is a milk-clotting gastric enzyme.
- Rennin is probably absent in humans; its function is carried over then by pepsin.
- Another enzyme of the stomach is gastric lipase. It splits the butter fat molecules found in milk. This enzyme operates best at a pH of 5 to 6. It has a limited role in adult stomach.
- The most important function of HCL secreted by stomach is to activate both pepsinogen and prorennin .it also kills micro-organisms like bacteria ingested with food and drink.

Digestion in small Intestine

The food in the small intestine is mixed with three digestive fluids namely Bile ,Pancreatic juice and Intestinal juice.

- **Bile**
 - a) Bile is secreted by liver and is stored in the gallbladder.
 - b) Daily secretion of bile in man is about 600 mL.
 - c) Bile is alkaline, viscous , yellow to green in colour , pH 7.8-8.6. There is no digestive enzyme in bile. Its main role in digestion is emulsification of fat.

d) The presence of bile in the small intestine is also necessary for the absorption of the fat – soluble vitamins A,D,E and K.

e) If a person's gallbladder is removed , the digestion of fat is affected . Acidity may continue in the duodenum.

- **Pancreatic juice**

a) Pancreatic juice, secreted by exocrine pancreatic acini, is a complete digestive juice.

b) Pancreatic juice takes part in the digestion of proteins, carbohydrates and fats.

c) Pancreatic juice is colourless watery fluid , slightly alkaline, pH 7.5-8 due to presence of sodium bicarbonate.

d) Pancreatic α - amylase is a starch splitting enzyme similar to ptyalin hydrolyzing starch and glycogen to the disaccharide maltose, the trisaccharide maltotriose and α - dextrins.

e) Trypsin and chymotrypsin are proteolytic endopeptidases. They are initially inactive trypsinogen and chymotrypsinogen.

f) In predator animals drinking the blood of their prey, trypsin hydrolyses fibrinogen of blood into fibrin leading to blood coagulation.

g) Pancreatic lipase hydrolyses the 1-and 3- bonds of triglycerides.

- **Intestinal juice**

a) Intestinal juice or succus entericus is mainly secreted by crypts of Lieberkuhn.

b) Intestinal juice is a clear yellow fluid with slightly alkaline nature pH of 7.6, contains water , mucus and enzymes that complete the digestion of carbohydrates, proteins, fats and nucleic acids.

- c) Daily secretion of intestinal juice in man is about 2-3 litres.
- d) The important enzymes in intestinal juice are;
- i. Enterokinase activates trypsinogen to trypsin.
 - ii. Erepsin contain exopeptidases changes tri- and dipeptides to amino acids.
 - iii. Disaccharidases act as follows:
- Sucrose -----Glucose + Fructose
- Maltose-----Glucose + Glucose
- Lactose-----Glucose + Galactose
- e) Digestion of all major nutrients of food is completed in the small intestine.
- f) The end products of carbohydrate digestion are monosaccharides.
- g) The end products of protein digestion are amino acids.
- h) The end products of fat digestion are fatty acids and glycerol.
- i) The end products of nucleic acid digestion are nitrogenous bases, pentose sugars and phosphoric acid.

Absorption

- Absorption of the digested food mainly occurs in ileum of small intestine.
- Monosaccharides and amino acids pass into the capillaries in the villi and fatty acid , glycerol and monoglycerides into lacteals.
- Other nutritional materials such as vitamins,mineral salts and water are absorbed from small intestine into blood capillaries.

- Lipid- soluble vitamins are absorbed into lacteals along with fatty acids and glycerol.
- Vitamin B₁₂ combines with intrinsic factor in the stomach and is absorbed in the terminal ileum .
- The contents of the small intestine passes into the large intestine.
- The absorption of water continues until the familiar semisolid consistency of faeces is achieved.
- Mineral salts, vitamins and some drugs are also absorbed into the blood capillaries from the large intestine.
- Bilirubin is altered by microbes in the large intestine.
- Some of the resultant urobilinogen is reabsorbed and then excreted in the urine, but most is converted to stercobilin.
- The brown colour of faeces is due to the presence of stercobilin.

Hormonal control of digestion

- Gastrin : G-cells of pyloric gland and duodenum secretes a hormone called gastrin which stimulates secretion of gastric juice.
- Enterogastrone / Gastric Inhibitory Peptide, GIP: Enterogastrone produced by small intestine slows down the secretion of gastric juice.
- Cholecystokinin : Release of bile into duodenum is promoted by a hormone CCK, which induces rhythmic contraction of the gallbladder.
- Secretin : Secreted by duodenum stimulates pancreas and controls the volume of pancreatic juice including water and electrolytes.
- Pancreozymin : Secreted by duodenum, controls the amount of enzymes in pancreatic juice.

- Enterocrinin : Secreted by small intestine stimulates intestine to secrete the intestinal juice.

Peristalsis

- The food bolus moves in the alimentary canal by a wave of relaxation followed by one of contraction. This movement of pushing the food is called as “propulsive peristalsis”.
- The movements in the gut wall are known as peristalsis.
- Peristalsis is an involuntary muscle relaxation and contraction.
- Peristaltic movements are found in different parts of alimentary canal.
- Peristalsis occurs usually in oesophagus, stomach and intestine. Least peristalsis occurs in rectum.
- The frequency of peristalsis is 3/min in stomach , 12/min in duodenum and 8-9/min in ileum.
- Peristalsis is a part of mechanical digestion.
- Stimulation of parasympathetic nervous system results in the increase of the gut peristalsis.
- Reverse peristalsis in the stomach produces vomiting.