

Nutrition

Defination -

Nutrition may be defined as the utilization of food by living organisms.

- Nutrition significantly promotes man's development, his health and welfare.
- Food is the fuel source of the body. The ingested food undergoes metabolism to liberate energy required for the vital activities of the body.

Calorific values of foodstuffs

- | | | | |
|-----------------|---|-----------|-------------|
| ① Carbohydrates | → | 4 kcal /g | or [Cal /g] |
| ② Fat | → | 9 kcal /g | |
| ③ Proteins | → | 4 kcal /g | |

Balanced Diet

The diet which contains different types of foods, possessing the nutrients - carbohydrates, fats, proteins, vitamins & minerals in a proportion to meet the requirements of body is called as balanced diet or prudent diet.

- A balanced diet invariably supplies a little more of each nutrient than minimum requirement to withstand the short duration of leanness & keep the body in a state of good health.

- The basic composition of balanced diet is highly variable, as it differs from country to country, depending on the availability of foods.
- The Indian balanced diet is composed of cereals (rice, wheat, jowar), pulses, vegetables, roots & tubers, fruits, milk & milk products, fats & oils, sugar & groundnuts.
- Meat, fish & eggs are present in the non-vegetarian diets.
- In case of vegetarians, an additional intake of milk & pulses is recommended.

Nutritional importance of carbohydrates

Dietary carbohydrates are the chief source of energy.

They contribute to 60-70 % of the total calories requirement.

Carbohydrates are the most abundant dietary constituents.

From the nutritional point of view, carbohydrates are grouped into 2 categories -

- 1) carbohydrates utilized by the body →
starch, glycogen, sucrose, lactose, glucose, fructose, etc.
- 2) carbohydrates not utilized (not digested) by body →
cellulose, hemicellulose, pectin, gums, etc.

- Among the carbohydrates utilized by the body, starch is the most abundant.
- The brain & other parts of CNS depend on glucose for energy.

Digestion

Digestion is a process involving the hydrolysis or breakdown of large & complex organic molecules of foodstuffs into smaller & molecules which can be easily absorbed by the gastrointestinal tract for utilization by the organism.

- Digestion as well as absorption are complicated processes that occur in the gastrointestinal tract involving many organs.

A) Digestion of Carbohydrates

The digestion of carbohydrates occur briefly in mouth & largely in the intestine.

- The Polysaccharides get hydrated during heating which is essential for their efficient digestion.
- The hydrolysis of glycosidic bonds is carried out by a group of enzymes called glycosidases.

1) Mechanical & chemical Digestion in the Mouth

- Mechanical digestion in the mouth results from 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 as bolus.

- Food molecules begin to dissolve in the water in saliva, because enzymes can react with food molecules in a liquid medium only.

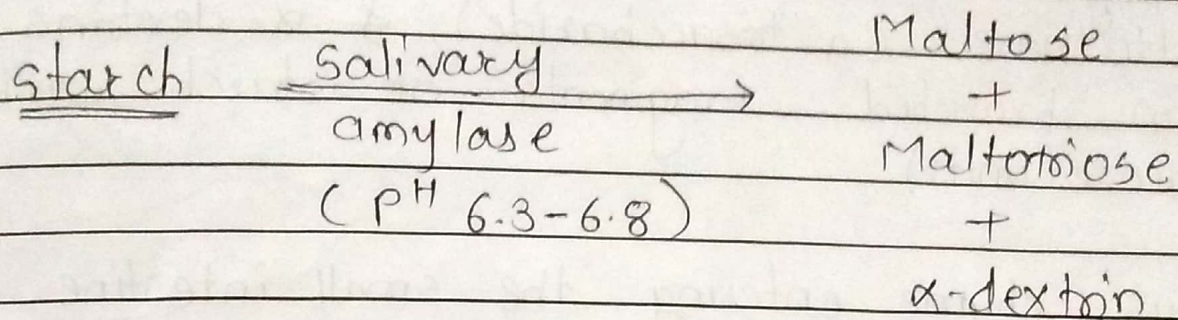
- Enzyme salivary amylase present in the saliva contribute to chemical digestion, in the mouth.

- salivary amylase secreted by salivary glands, initiates the breakdown of starch.

- Most of the ^{carbohydrates} ~~starches~~ we eat are starches, but only monosaccharides can be absorbed into the bloodstream. & Thus, ingested disaccharides & starches must be broken down into monosaccharides.

- The function of the salivary amylase is to begin starch digestion by breaking down the starch into smaller molecules such as disaccharides maltose, trisaccharide maltotriose,

and short-chain glucose polymer called as α -dextrins.

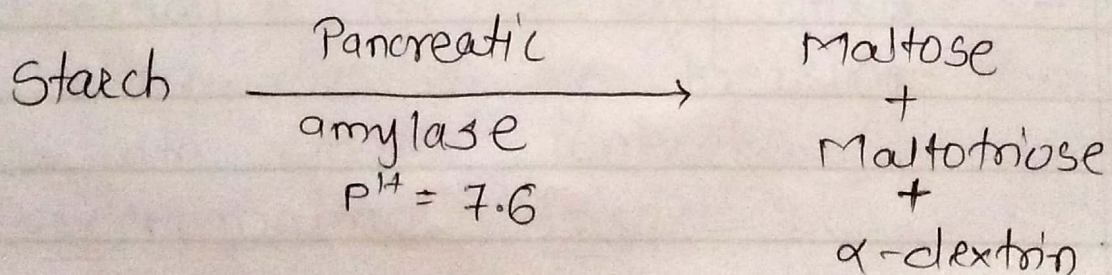


- Even though food is usually swallowed too quickly for all the starches to be broken down in the mouth, salivary amylase in the swallowed food continues to act on the starches for about another hour, upto the time stomach acid inactivate it
- Food may remain in the fundus for about an hour without becoming mixed with gastric juice. During this time, digestion by S. amylase continues.
- Soon, however, the churning action mixes chyme with acidic gastric juice, inactivating salivary amylase.

2) Mechanical and chemical digestion in the stomach small intestine

- In the mouth, salivary amylase converts starch (a polysaccharide) to maltose (a disaccharide), maltotriose (a trisaccharide), & α -dextrins (short chain, branched fragments of starch with 5-10 glucose units).
- Thus, chyme entering the small intestine or duodenum contains partially digested carbohydrates.
- The completion of the digestion of carbohydrates is a collective effort of pancreatic juice, bile & intestinal juice in the small intestine.
- Even though the action of salivary amylase may continue in the stomach for a while, the acidic pH of the stomach destroys s. amylase & ends its activity. Thus, only a few starches are broken down by the time of chyme leaves the stomach.

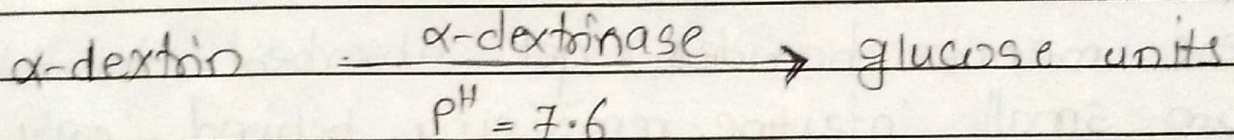
Those starches not already broken down into maltose, maltotriose & α -dextrins are cleaved by pancreatic amylase, ~~a~~^a pancreatic enzyme.



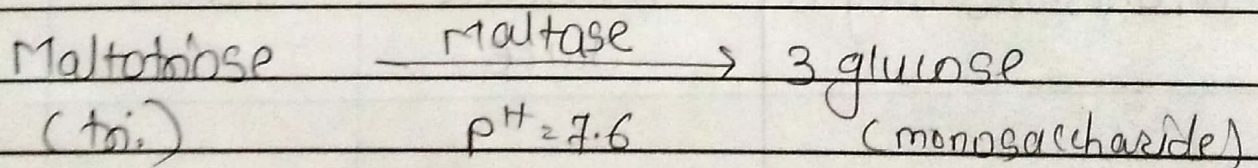
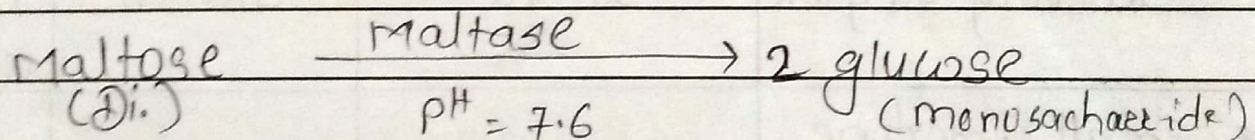
- After amylase (salivary or pancreatic), brush border enzymes of small intestine act on remaining carbohydrates & convert it into finally monosaccharides.

- ^{Brush}~~Brush~~-border enzymes act as follows -

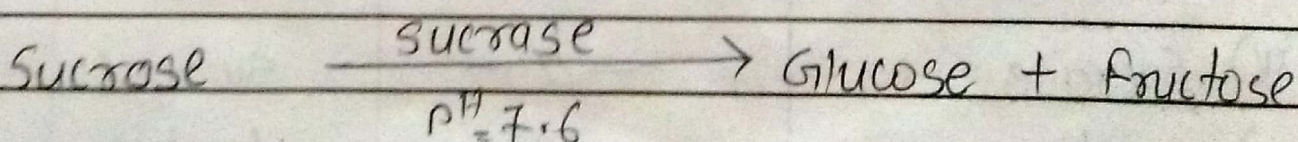
1) α -Dextrinase - It acts on resulting α -dextrins, & remove one glucose at a time.



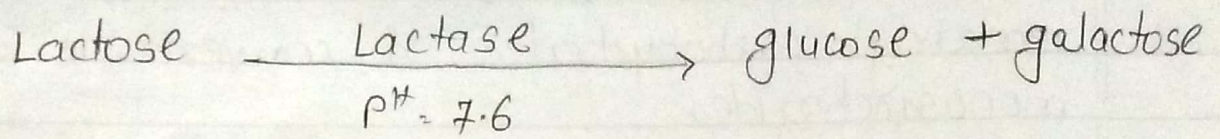
2) Maltase = It acts on ingested maltose & maltotriose & convert it into two & three glucose unit respectively.



3) Sucrase = It acts on sucrose and convert it into glucose & fructose monosaccharide unit.



4) Lactase = It act on Lactose & convert it into glucose & galactose monosaccharide units.



- After the action of brush-border enzymes, ingested carbohydrates finally get converted into monosaccharides, except the undigested carbohydrates like cellulose & fibers.
- These monosaccharides get absorbed in blood streams from small intestine, remaining behind only indigestible cellulose & fibers in the feces.

Enzymes	Source	Substrate	Product
* Mouth Salivary amylase	Saliva	Starch	Maltose, Maltotriose α -dextrin
* Small intestine i) Pancreatic amylase	Pancreatic Juice	starch	maltose, maltotriose α -dextrin
ii) α -dextrinase	Brush Border	α -dextrin	glucose
iii) Maltase	Brush border	Maltose Maltotriose	glucose
iv) Sucrase	—//—	sucrose	glucose + fructose
v) Lactase	—//—	Lactose	glucose + galactose

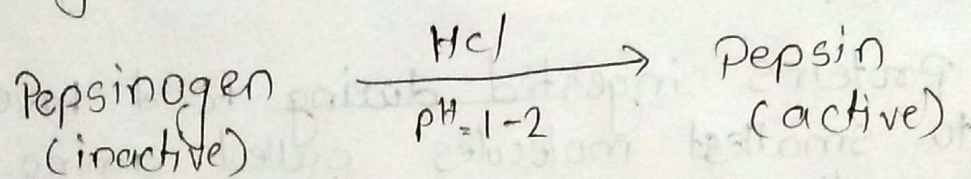
B) Protein Digestion

- Proteins are body building foods.
- 10-15% of the total body energy is derived from proteins.
- Proteins are the fundamental basis of cell structure & its function.
- All enzymes, several hormones, immunoglobulins, transport carriers etc
- The proteins ingested during food have to convert it into smallest molecules called amino acid.
- Protein digestion start in the stomach, & ends in small intestine.

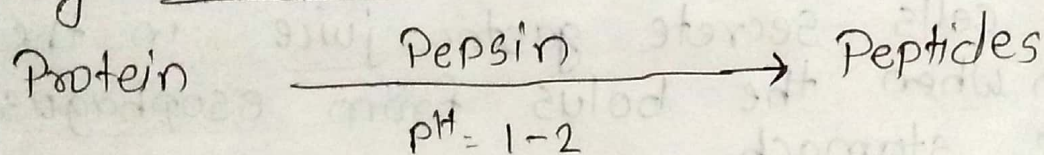
i) Mechanical & chemical Digestion in stomach

- Stomach cells secrete gastric juice in the stomach, in which when the bolus from esophagus comes into the stomach.
 - HCl is secreted by parietal cells which makes the acidic environment in stomach with pH about 1-2, & denatures the protein & kill microbes.
 - Gastric juice also contain proteolytic enzyme which is secreted by chief cells.
- Several minutes after food enters the stomach, gentle, rippling, peristaltic movements called mixing waves pass over the stomach.
- These waves masticate the food & mix it with gastric juice & reduce it to a soupy liquid called chyme.

- The proteolytic enzyme present or secreted in stomach is pepsin, but it is secreted in inactive form called pepsinogen, which get converted into active form when the HCl in gastric juice act on it.
- In other words, in presence of HCl only, the pepsinogen get converted into active form pepsin.



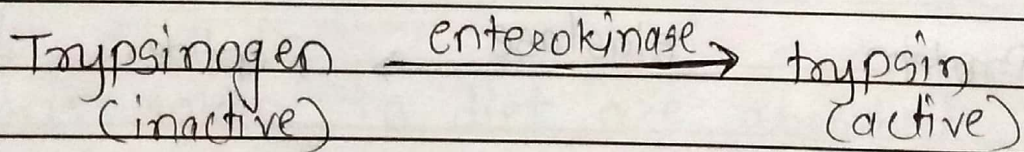
- Now, this activated pepsin act on the proteins which are ingested through diet and convert it into peptides, (fragments of proteins), by breaking peptide bond between amino acids.



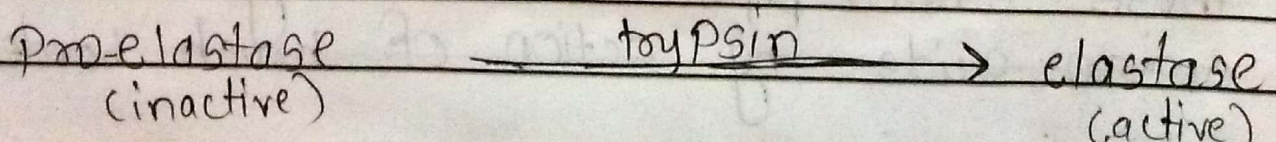
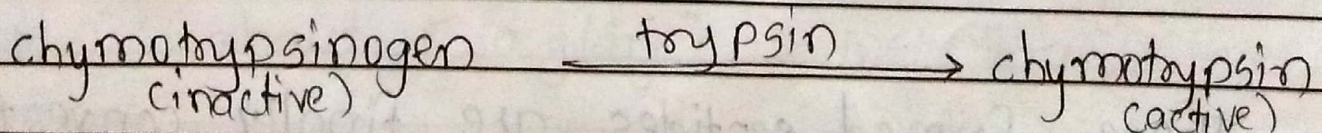
- After protein digestion in stomach, chyme enter into small intestine through pyloric sphincter.
- pyloric sphincter normally remain close but not completely closed. As food reaches the pylorus, each mixing wave periodically forces about 3 ml of chyme into the duodenum. this phenomenon known as gastric emptying.

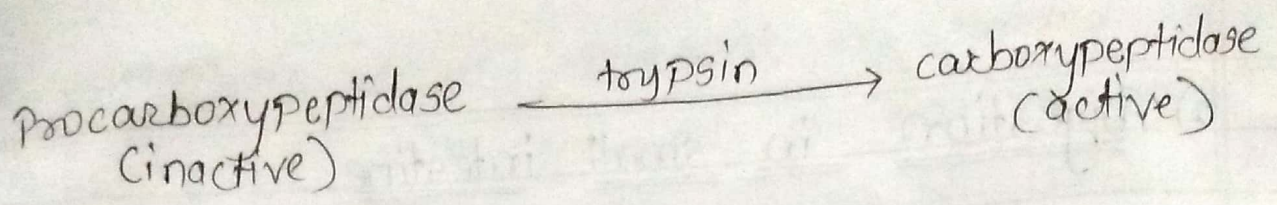
2) Digestion in small intestine

- Chyme enters into the small intestine contains proteins & peptides.
- Pancreatic juice & bile released in duodenum helps in neutralizing the acidic chyme & make the pH of duodenum upto 7.6.
- Pancreatic juice contains proteolytic enzymes like trypsin, chymotrypsin, elastase and carboxypeptidase.
- These enzymes are synthesized & secreted into their inactive form i.e. trypsinogen, chymotrypsinogen, proelastase & procarboxypeptidase.
- They get convert into their active form in the small intestine only.
- Brush border enzyme enterokinase act on trypsinogen enzyme & convert it into active form trypsin.

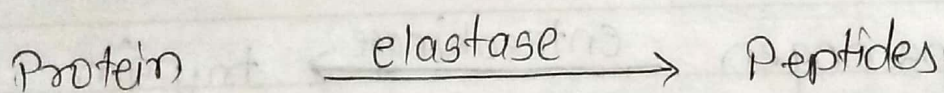
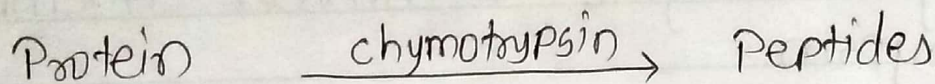
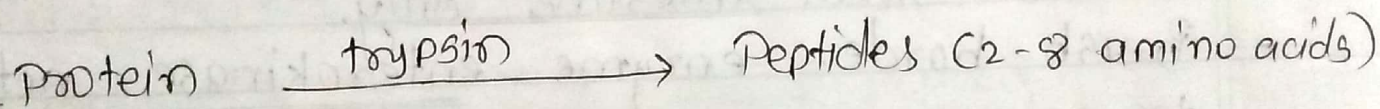


- Active form of trypsin now, act on inactive form of Pancreatic proteolytic enzymes and convert these enzymes in their active form

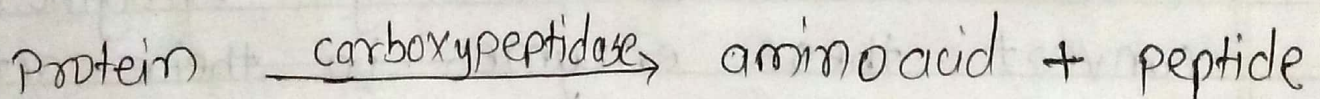




- Now, these activated pancreatic proteolytic enzymes act on remaining proteins and convert these proteins into peptides.
- Although all these enzymes convert whole proteins into peptides, their action differs somewhat because each splits peptide bonds between different amino acids.
- Trypsin, chymotrypsin, and elastase all cleave the peptide bond between a specific amino acid & its neighbor.



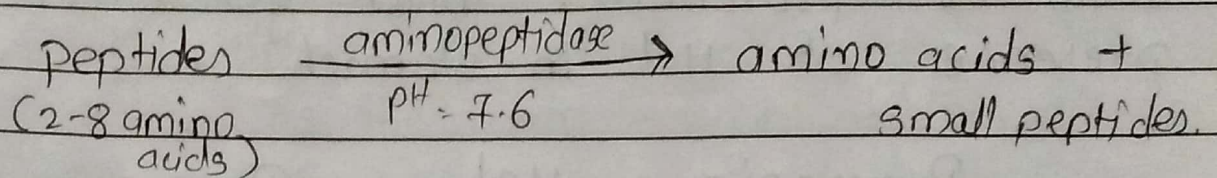
- carboxypeptidase splits off the amino acids at the carboxyl end of a peptide.



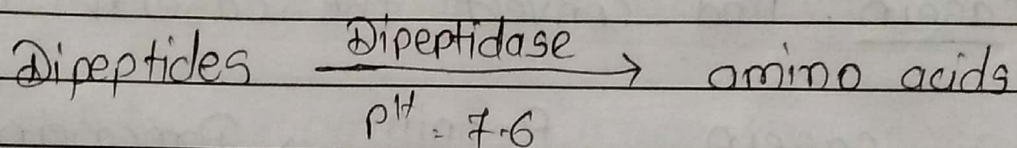
- These formed peptides are finally converted into amino acids by action of brush border enzymes.

- Proteolytic enzymes synthesized by brush border cells are aminopeptidase and dipeptidase.

- Aminopeptidase cleaves off the amino acid at the amino end of peptide



- Dipeptidase splits dipeptides [two amino acids joined by a peptide bond] into single amino acids.

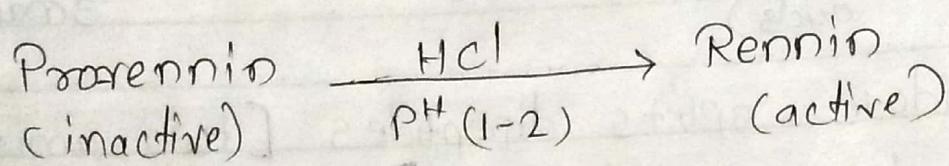


- After complete digestion of proteins into amino acids, these amino acids are absorbed in the blood.

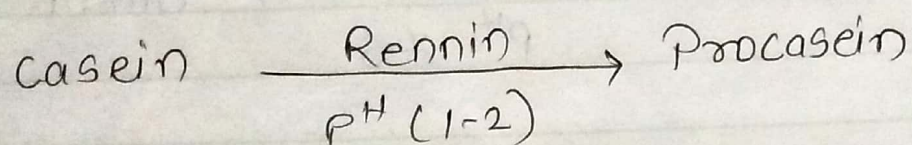
- Proteins taken in diet are absorbed in blood in the form of amino acids, dipeptides & tripeptides.

- The digestion & absorption of proteins is very efficient in healthy humans, hence very little protein (about 5-10 g/day) is lost through feces.

- In infants and childrens an another enzyme is present in stomach called as Rennin. Which is help in curdling of milk.
- Rennin is secreted by chief cells & in inactive form called as prorennin. which get activated in presence of HCl in stomach.



- This activated rennin act on milk protein called as casein. And convert the casein into procasein



This Procasein combine with Ca²⁺ present in milk and form calcium Procaseinate. which get separate from the milk & is called as curdling of milk.

Lipid Digestion

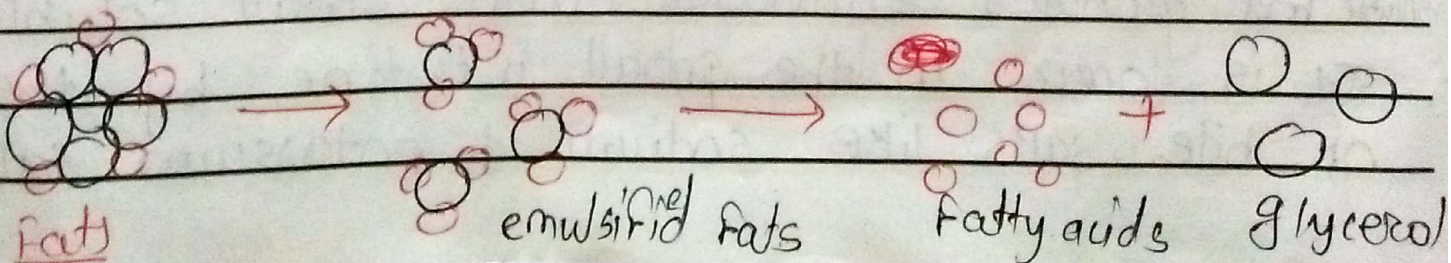
Page No :

Date :

Lipids include fats, oils, waxes, etc. They are natural compounds of $C, H \& O$.

- They are insoluble in water but soluble in fat solvents like ether, chloroform, boiling alcohol & benzene.
- chemically, lipids are esters of fatty acids.
- Fats serve as the main source of energy in organisms.
- It is a storage food in organisms.
- They are responsible for cell permeability & cell organization.
- They serve as vehicle for fat soluble vitamins A, D, E & K.
- Fats provide support for many organs in the body such as heart, kidney & intestine.
- The calor lipids / Fats provide energy about 9 kcal / gm.
- Lipids ~~are~~ in the diet include neutral fats, phospholipids, cholesteryl esters, free cholesterol fatty acids & glycerol.
- During digestion, the lipids are split into fatty acids & glycerol.

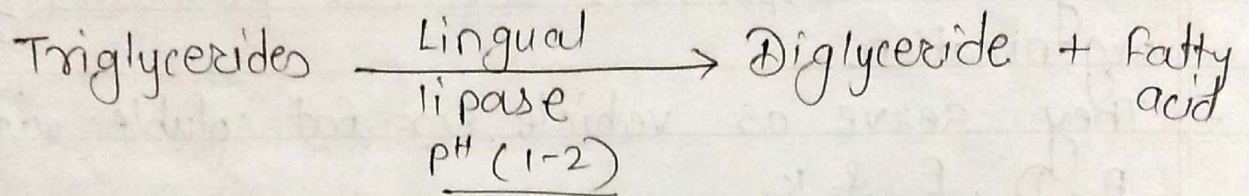
Lipids $\longrightarrow$ fatty acid + glycerol



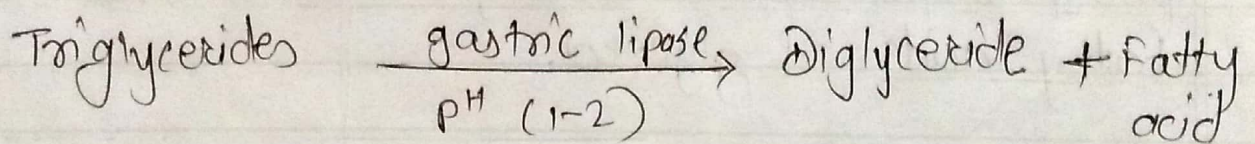
The digestion of lipid occurs in the stomach & intestine. It does not occur in buccal cavity.

1) Digestion in stomach

- Digestion of lipids or triglycerides start in stomach.
- Lingual lipase enzyme present in saliva of mouth act on lipid only in low pH (1-2). Thus, low pH present in stomach due to HCl secreted in stomach, lingual lipase act on Triglycerides & convert it into diglyceride & free fatty acids.



- In stomach, gastric juice present lipid digesting enzyme called gastric lipase. It is secreted by chief cells of stomach. It also digest the triglycerides into diglyceride & free fatty acids.



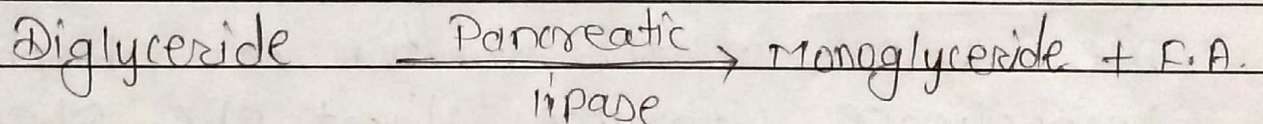
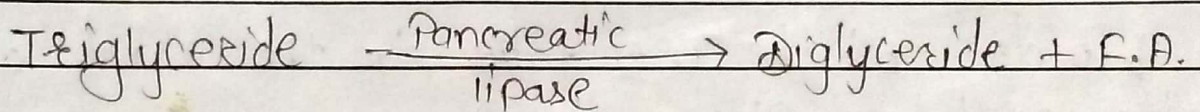
- For the digestion of lipids, it need to first emulsification of fats / lipids.

- Emulsification is the process by which large insoluble fat globules converted into small soluble globule.
- It is occur in the small intestine by the action of bile salts like sodium & potassium salts present.

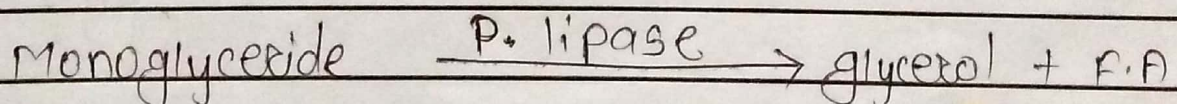
in bile. Because of the emulsification process not occur in stomach, the digestion of fat by lingual & gastric lipase is very small quantity or negligible.

* Digestion in small intestine

- In After the acidic chyme enter into the small intestine first emulsification of fat occur.
- After emulsification of fat, 'pancreatic lipase' a lipid digesting enzyme act on triglycerides and convert into diglyceride & fatty acid, after that it act on diglyceride & convert it into monoglyceride & fatty acid.



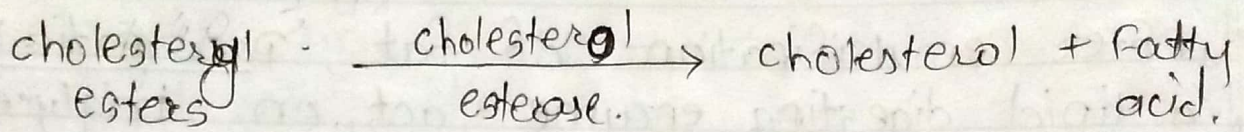
- Finally monoglycerides convert into glycerol & free fatty acid.



- The formed, monoglycerides, glycerol, fatty acids are easily absorbed into the blood streams.

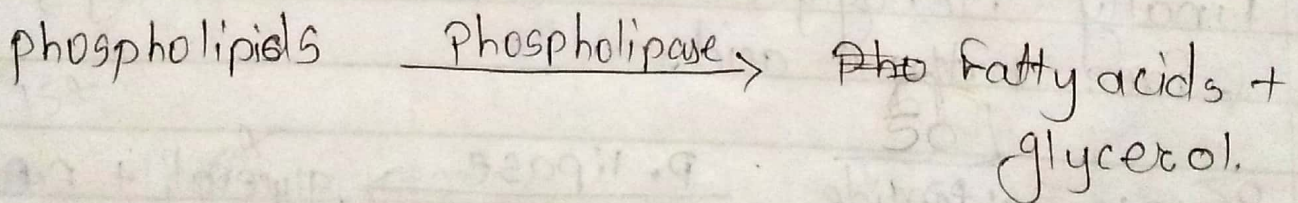
Digestion of cholesteryl esters

- Dietary lipids also contain cholesteryl esters, which are digested in the small intestine.
- Pancreatic juice contains the enzyme which digests the cholesteryl esters called as or named as cholesterol esterase.
- Cholesterol esterase breaks it into cholesterol & free fatty acid.



Digestion of phospholipids

- Lipids which we take in the food or in diet also contain phospholipids.
- Phospholipase enzyme present in pancreatic juice helps in the digestion of phospholipids.
- phospholipase enzyme digests the phospholipids & forms free fatty acids and glycerol.



Finally, the digested products like cholesterol, free fatty acids, glycerol, monoglyceride get absorbed in the blood stream.